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THESIS

AN EVALUATION OF THE APPLICATION OF ECONOMIC ANALYSIS AND COST-BENEFIT ANALYSIS TOOLS IN THE DOD ENVIRONMENT

by

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June 2000

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This thesis reviews the application of cost-benefit analysis (CBA) in the Department of Defense (DOD) and the software and automated tools used in these applications. The thesis focuses on the analytic capabilities of the software and tools as applied to cost-benefit analysis problems in the DOD environment. The principles of cost-benefit analysis are used to evaluate the utility of the existing software applied to DOD cost-benefit analyses. The research identifies the cost-benefit analysis automated tools used in the DOD and the regulations that apply to cost-benefit analyses in the DOD. It also lists the organizations involved in conducting CBA. By reading the list of tools and their features, readers will become aware of what is currently available in DOD to facilitate the reliability of CBA. The study also focuses on the ECONPACK software developed by the U.S. Army Corps of Engineers. ECONPACK's strengths and weaknesses are analyzed. Also, ECONPACK is used to replicate two earlier studies – one a cost-benefit analysis of retail activities at military bases, the other a cost-effectiveness study of the operational availability of the Brazilian and Argentinean A-4 fleet. The replications demonstrate that ECONPACK is designed to support cost and cost-effectiveness analyses rather than true cost-benefit analyses.

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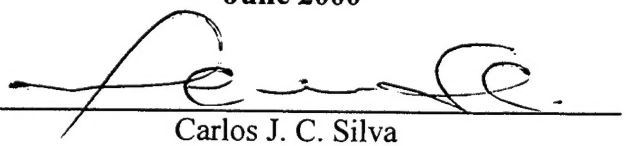
Authors: 
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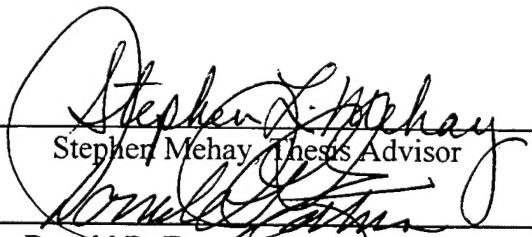
Approved by: 
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This thesis reviews the application of cost-benefit analysis (CBA) in the Department of Defense (DOD) and the software and automated tools used in these applications. The thesis focuses on the analytic capabilities of the software and tools as applied to cost-benefit analysis problems in the DOD environment. The principles of cost-benefit analysis are used to evaluate the utility of the existing software applied to DOD cost-benefit analyses.

The research identifies the cost-benefit analysis automated tools used in the DOD and the regulations that apply to cost-benefit analyses in the DOD. It also lists the organizations involved in conducting CBA. By reading the list of tools and their features, readers will become aware of what is currently available in DOD to facilitate the reliability of CBA. The study also focuses on the ECONPACK software developed by the U.S. Army Corps of Engineers.

ECONPACK's strengths and weaknesses are analyzed. Also, ECONPACK is used to replicate two earlier studies – one a cost-benefit analysis of retail activities at military bases, the other a cost-effectiveness study of the operational availability of the Brazilian and Argentinean A-4 fleet. The replications demonstrate that ECONPACK is designed to support cost and cost-effectiveness analyses rather than true cost-benefit analyses.

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I. INTRODUCTION

A. PURPOSE

During the last few years, the US Government has been showing a firm commitment to streamlining and reinventing government practices. One of the methods used to improve performance and management techniques is to increasingly use information technology to solve management problems, and especially to benefit from the ability of computer-based systems to maintain large historical data bases. Following the automation trend, the U. S. Department of Defense (DOD) has been making significant efforts to review procedures and provide automated tools to managers.

The application of cost-benefit analysis is one area where the government has made strides in providing decision support tools to managers. The government is committed to the development of a database of costs and benefits, and to the use of consistent assumptions and better estimation techniques to refine each agency's planning and budgeting process. Cost benefit analysis software and automated tools ease the burden of performing a thorough analysis and adding consistency and accuracy to the decision making process.

The purpose of this thesis is to review the principles and the application of cost-benefit analysis and to review the current state of cost-benefit analysis software and tools being used in DOD. The thesis focuses on the analytic capabilities of the software and tools as applied in DOD and various situations in which cost-benefit analysis can be applied. The principles of cost-benefit analysis will be used to evaluate the utility of the existing software and the application of automated techniques to DOD cost-benefit analyses.

B. RESEARCH QUESTIONS

The following is a list of the primary research questions addressed by this thesis:

- What are the efforts throughout DOD to refine the agency's analytical capabilities and to develop software to apply cost-benefit techniques?

- What is the current state of software and automated tools being used in DOD to perform cost-benefit analyses?

- Are the software and automated tools currently used in congruence with the theoretical framework underlying cost-benefit analysis? Are they in congruence with norms and regulations?

A secondary question addressed in this thesis is:

- Does the ECONPACK software developed by the US Army Corps of Engineers add value to the process of performing cost-benefit analysis studies? What are the advantages and disadvantages in using ECONPACK in cost-benefit analysis studies in general and in particular in DOD?

C. ORGANIZATION OF STUDY

This thesis is organized in six chapters. Chapter I introduces the cost-benefit analysis theme, present the research questions addressed in the study, outlines its organization, describes the methodology used, and enumerate the expected benefits of the thesis.

Chapter II presents the background of cost-benefit analysis studies in the Federal government and throughout DOD. This chapter presents a brief history of how cost-benefit analysis became an important tool to support the budgetary decision-making process.

Chapter III presents an overview of cost-benefit analysis theory. To provide the reader with sufficient information about cost-benefit analysis, we describe its conceptual framework, specific elements, common errors, and norms and regulations constraining cost-benefit analysis studies. Although readers with a strong background in economics and cost-benefit analysis might find the discussion useful as a refresher, they may choose to skip this chapter.

In Chapter IV, we identify the cost-benefit analysis software and tools used in the DOD environment. We discuss and analyze its characteristics based on the fundaments depicted in the previous chapter. Chapter V focuses on the ECONPACK software, analyzing its capabilities, strengths and weaknesses as an automated tool in the application of cost-benefit analysis principles. This chapter also presents two examples of cost-benefit problem framed by ECONPACK. Finally, Chapter VI presents the conclusions and recommendations of this thesis

D. METHODOLOGY

This thesis used archival research of books, research papers, Internet articles and a review of current literature on cost-benefit analysis. In order to identify the software and tools related to cost-benefit analysis, an extensive research of DOD web sites was

conducted. From the list of software and tools identified, we developed an assessment of their capabilities, based on the theory of cost-benefit analysis and on the existing DOD regulations. The aim of the analysis was to validate the software and tools using the theoretical principles of cost-benefit analysis and verify their value in applied studies. We selected ECONPACK and conducted an in-depth analysis of the software to identify its capabilities, strengths and weaknesses. We used ECONPACK to replicate recent cost-benefit analysis studies to demonstrate our findings.

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II. BACKGROUND

> the true rule, in determining to embrace or reject any thing is not whether it have any evil in it; but whether it have more of evil, than of good. There are few things wholly evil, or wholly good. Almost every thing, especially of government policy, is an inseparable compound of the two; so that our best judgment of the preponderance between them is continually demanded."
>
> Abraham Lincoln

A. INTRODUCTION

Cost benefit-analysis studies play an important role in the budgetary decision making process. It is the framework used by Federal government agencies to justify spending and enhance the better use of scarce resources. This Chapter presents the background of cost-benefit analysis studies in the Federal government and throughout DOD. It arrays a brief history of cost-benefit analysis and how it became an important and required tool to support the budgetary decision-making process

B. A BRIEF HISTORY

The literature on CBA dates from 1844, with the publication of the essay "On the Measurement of the Utility of Public Works" by Jules Dupruit, a French engineer. Dupruit stated in his essay:

> Legislators have prescribed the formalities necessary for certain works to be declared of public utility; political economy has not yet defined in any precise manner the conditions which these works must fulfill in order to be really useful; at least, the ideas which have been put about on this subject appear to us to be vague, incomplete and often inaccurate. [Ref. 1:p. 83]

Dupruit's major contribution to the economic literature was the idea that the output of a project multiplied by its price is equal to the minimum social benefit of a project; some consumers might be willing to pay more than the market price and so enjoy excess utility. The concept of excess utility was later labeled by Alfred Marshall as consumer's surplus. This idea led directly to the concept of net social benefit, which now is basic to CBA. [Ref. 2:p. 4]

Dupruit's essay represented the beginning of a line of thinking that influenced the budgetary process and modified how government opted among projects. In spite of its vagueness, incompleteness and inaccuracies, as Dupruit pointed out, the recognition that

analytical tools should be used to measure the benefits of a project was the first step toward a more systematic use of CBA as a method to evaluate policies.

The first practical application of CBA occurred many years after Dupruit's essay, when CBA formally became part of the Flood Control Act of 1936. By this act, the Congress declared that benefits of federal projects "to whomsoever they may accrue (be) in excess of estimated costs." [Ref. 8:p. 2] However, no standardized procedure was determined and different agencies adopted different rules to estimate costs and benefits of their projects.

In 1950, the Subcommittee on Benefits and Costs of the Federal Interagency River Basin Committee prepared a report that evolved into a standard guide for water resource planners. This document, which is known as the Green Book, applied welfare economics concepts to project appraisal. It consisted of a formal set of rules to regulate economic analysis practices of River Basin projects.

Later in 1952, the Bureau of the Budget issued its Budget Circular A-47, setting guidance in evaluating proposed projects by the bureau. This circular remained the official guide for project evaluation into the 1960's. Circular A-47 was replaced by Senate Document 97, in 1962. After an extended review, the Senate document was replaced in 1973 by "Principles and Standards for Planning Water and Related Land Resources." The revision included beneficial and adverse effects in terms of society's perspective, trade-off among plans, national and economic development, environmental quality, and social well-being. [Ref.2:p. 5]

Concurrently, the government began to rule the budgetary system. Under President Lyndon Johnson the government tried to adopt a Planing Programming Budget System (PPBS) to aid in making spending decisions. PPBS was a more systematic use of CBA methods and was introduced as an extension of system analysis in the Department of Defense. Under President Carter the Office of Management and Budget tried to adopt a Zero-Based Budgeting System to achieve the same end. And under President Ronald Reagan the government tried to apply formal cost-benefit analysis to health, safety, and environmental regulations. [Ref. 8:p. 2]

The government's efforts in the budget field and in reviewing existing regulations instated the construction of a theoretical base in schoolary circles. In Harvard University, RAND and other schools, an extensive literature on CBA began to grow.

C. CBA NOWADAYS

The Office of Management and Budget (OMB) transformed CBA in an essential evaluation tool to the design and formulation of policies in federal agencies,

incorporating straightforward guidelines consistent with the premises and the logic of CBA. [Ref. 4:p. 4]

First issued in 1972 and reviewed in 1992, OMB Circular A-94 is the instrument that integrates the principles of CBA in the decision-making process in federal agencies, providing guidance on the use of CBA in evaluating federal programs. Circular A-94 clearly states the purpose of its guidelines to be the promotion of efficient resource allocation though well-informed decision-making by the Federal Government. [Ref. 10]

Within the Department of Defense (DOD), DOD Instruction 7041.3, published in 1995, authorizes the Defense Economic Analysis Council (DEAC), which has the responsibility of developing standardized format and documentation requirements and identify support tools to insure consistent, complete economic analysis submission. OMB Circular A-94 and DODI 7041.3 will be further discussed in Chapter III and IV respectively.

Additionally, the government set management reforms in the 1990's to make agencies more accountable for getting a good return on taxpayers' dollars. The National Performance Review, later renamed the National Partnership for Reinventing Government calls for business-like government practices, focusing on return on investment of government spending and on financial accountability and cuts on the work force.

The 1993 Government Performance and Results Act (GPRA) ties funding decisions directly to program performance. It requires agencies to set outcome goals, measure performance and report accomplishments. The reports must be coupled with cost data to aid funding decisions. The act motivates analysts to replace internal budget reports with useful, real-time cost data to help them choose the most effective approaches to achieving output goals.

The 1996 Federal Financial Management Improvement Act (FMIA) determines that financial systems should comply with federal standards, better serving agencies' decision-makers. The financial data will be used to evaluate decisions and a strong support in information technology (IT) will be used to support financial and cost data retrieving. [Ref. 25:p. 12]

The government efforts mentioned above represent the background for the growing need of CBA studies and, furthermore, to the need of automated supporting software and tools to perform accurate cost and benefits evaluation of government policies.

D. CBA AND THE POLICTICAL ENVIRONMENT

Although the CBA framework is simple and useful as an organizing device to support the choice among alternative government policies, the reader should avoid the common misconception that CBA is a mechanical substitute for common sense. CBA is a technique to organize thoughts and subsidize decision-makers with informed and standardized data. Its completeness and accuracy depends on conjectural considerations which sometimes are difficult, or even impossible, to be measured or quantified. CBA is a process to inform decision-makers through policy advice rather than a process that makes the final decision. This point is clearly stated by John Maynard Keynes in his introduction to the Cambridge Economic Handbook:

> The theory of economics does not furnish a body of settled conclusions immediately applicable to policy. It is a method rather than a doctrine, an apparatus of the mind, a technique of thinking, which helps its processor to draw correct conclusions.

Another common misconception is that cost and benefit data are systematically available and are easy to gather. Analysts often face enormous difficulties in finding accurate data to perform CBA studies. Besides uncertainty, that obscures the cost and benefit estimates, a major reason to the lack of sufficient data is the almost non-existent literature on *ex post* CBA. *Ex post* CBA is conducted at the end of a project, when all costs and benefits were accrued and, therefore, uncertainty plays a smaller role. The value of *ex post* analysis is that it provides information not only about a particular project but also about the "class" of such project, contributing to the learning process about whether particular classes or types of projects are worthwhile. In addition, comparison studies between *ex ante* (standard) and *ex post* CBA provides analysts with a source of data useful for learning about the efficacy of CBA as an evaluative tool. [Ref. 3:p. 3]

In spite of the advantages of performing *ex post* CBA, there is no regulation compelling federal agencies to perform such analysis. *Ex post* analysis and comparison studies between *ex ante* and *ex post* CBA could represent a major source of information if the studies were performed routinely. However, motivation to perform these types of studies is not easily found in the political environment and government efforts to streamline government procedures do not even mention these studies. Agencies, consequently, pay little attention to measure the effects of a project after its conclusion. This fact seems to be the principal reason justifying the unavailability of data to support more accurate CBA studies.

E. CHAPTER SUMMARY

This chapter outlined a brief history of CBA. It lists the main literature related to CBA studies since its early days. Also, the government efforts to improve internal practices are mentioned. The correlation between CBA studies and government's management reform is established. Finally, the influence of the political environment and the consequent misconceptions about CBA are pointed to entitle the reader's understanding about the subjectivism behind CBA analytic methods. With this idea in mind, the reader will more easily understand the concepts we will present in the next chapter and recognize CBA strengths and weaknesses in evaluating public policies.

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III. OVERVIEW OF COST-BENEFIT ANALYSIS CONCEPTS

A. INTRODUCTION

The term cost-benefit analysis (CBA) has been broadly used, sometimes erroneously. It is a generic term embracing a wide range of evaluative procedures. In fact, cost-benefit analysis is a very specific method for evaluating public policies and programs.

This chapter presents an overview of cost-benefit analysis theory. First, we discuss the purpose and use of CBA. Then, we present the basic theory behind CBA. We discuss measures of allocative efficiency, measures of benefits and costs in efficient and inefficient markets, discounting mechanisms and the effect of uncertainty. We continue by showing the most common errors in CBA studies and alternative techniques when constraints limit standard CBA studies. Finally, we discuss OMB Circular No. A-94, which regulates CBA studies performed in most federal government agencies. This chapter intends to provide readers with sufficient information about cost-benefit analysis, so they can more easily understand the conclusions we derive in the next chapter.

B. PURPOSE AND USE OF CBA

The purpose of CBA is to provide an objective technique to help social decision making. More specifically, the objective is to facilitate the efficient allocation of society's resources. [Ref. 3:p. 2] CBA is a framework for organizing information objectively and independently of ideology, personal biases or values. It can be defined as:

> An estimation and evaluation of net benefits associated with alternatives for achieving defined public goals. [Ref. 2:p. 3]

CBA can also be understood as:

> An analytic framework for organizing thoughts, listing the pros and cons of alternatives, and determining values for all relevant factors so that the alternatives can be ranked. [Ref. 7:p. 1]

Therefore, one of the most important reasons to use CBA is that it appears to be coherent and persuasive because of the predominance of objective models of thought and analytical details. Indeed, subjectivism is present in data collection, but CBA structures

data and relationships in an objective and comprehensive way so as to avoid ideological influences and helping to obtain logical conclusions.

CBA studies allow analysts to identify costs and benefits from society's perspective, in terms of social gains and losses rather than cash or revenue flows. The procedure involves a systematic categorization of impacts as benefits and costs, valuing them in dollars and then determining the net benefits (benefits minus costs) of the proposal [Ref. 3:p. 2]. Consequently, CBA contributes to public policy decision making by assisting in the decision about whether scarce social resources should be allocated to a specific policy or program. In addition, CBA provides historical data for future studies. When the analysis is conducted at the end of a project, all costs and benefits are accrued and there is less uncertainty about the accuracy of the study. The collection and analysis of such data provides significant information to future projects, contributing to the learning process and to the evaluation of future projects.

C. MEASURES OF ALLOCATIVE EFFICIENCY

CBA is frequently considered as a protocol for measuring allocative efficiency [Ref. 3:p. 28]. It serves as a framework to make judgments of alternative resource allocation decisions based on the criterion of relative efficiency. This definition requires understanding the concept of efficiency.

1. Pareto Efficiency

Modern welfare economics defines Pareto Efficiency in the following way:

> An allocation of goods is Pareto efficient if no alternative allocation can make at least one person better off without making anyone else worse off. [Ref. 3:p. 29]

In other words, resources can only be rearranged to improve the well-being of one person at the expense of the well-being of another person. Thus if a new combination of resources can be found that makes one person better off without making another person worse off, then the new combination will improve efficiency.

That is, if any allocation of resources is not satisfying the Pareto Efficiency criterion, there is a possibility for a Pareto improvement. The calculated net benefits of a government investment project provide the condition for Pareto improvement, so:

> If a policy has positive net benefits, then it is possible to find a set of transfers that makes at least one person better off without making anyone else worse off." [Ref. 3:p. 30]

The Pareto Efficiency criterion appears to be very difficult to apply in practice. It implies that every person who loses from a project be compensated; thus, benefits and

costs should be measured for each individual and compensation transferred at the individual level, causing CBA studies to become extremely expensive and complicated. Also, the requirement of compensation at the individual level may create a situation where people overstate costs and understate benefits, distorting the value of the project.

2. Potential Pareto Efficiency

Alternatively, analysts use a modified criterion referred to as Potential Pareto Efficiency, or the Kaldor-Hicks rule, to justify any reallocation of resources in a more practical way. [Ref. 4:p. 16] S, as losers can be compensated and the policy or project can satisfy the Pareto improvement condition.

The Kaldor-Hicks rule can be stated:

> A Kaldor improvement is a change from a given output-mix distributed in a given way to another output-mix which would enable the gainers to compensate the loosers while continuing to gain themselves. Since the compensation need only to be hypothetical, a Kaldor improvement offers only a potential Pareto improvement. [Ref. 5:p. 182]

The Potential Pareto Efficiency criterion provides the basis for two important practical decision rules used in CBA studies. First, adopt all and only policies that have positive net benefits. Second, choose the combination of policies that maximizes net benefits.

D. CONSUMER'S SURPLUS AND WILLINGNESS TO PAY

In CBA studies, the value of a good to a person is measured in terms of what this person is willing-to-pay for this good. A simple definition of consumer's surplus is:

> It is the maximum sum of money a consumer would be willing to pay for a given amount of the good, less the amount he actually pays. [Ref. 6:p. 23]

Analysts should survey the payments each person would have to make or to receive under the policy and how it differs from the status quo. For example, if person 1 is indifferent between paying $50 to have a policy and the status quo, the $50 value is her willingness-to-pay (WTP) for this policy. The aggregate sum of these values for all members of the society affected by the policy represents the net benefits of the impacts of the policy. The WTP amounts can be positive if a person places positive value on the policy. Alternatively, WTP can be negative if a person opposes the policy and would have to be compensated if the policy were implemented. The positive amounts are considered the benefits of the policy and the negative values the costs. Linking the concept of WTP with the Potential Pareto Efficiency described earlier, we derive that if

and only if the aggregate net benefits of the policy as measured by the willingness-to-pay of affected individuals are positive, then there exist sets of contributions and payments that make the policy a Pareto improvement over the status quo. [Ref. 3:p. 31]

E. OPPORTUNITY COST

In order to be implemented, a policy or program requires inputs – capital, labor, materials, etc. The use of these inputs should be measured in terms of what society must forgo elsewhere when they are employed in a given use. So, the opportunity cost of using an input to implement a policy or program is its value in the best alternative use [Ref. 3:p. 31].

Analysts use opportunity cost to place a dollar value on the inputs needed to implement a policy. In examining the possibility of implementation of a policy, analysts should question whether it would satisfy the Pareto improvement rule. The required inputs, measured in terms of opportunity costs, should be compared with the status quo and if the net benefits of a policy are positive, then it is potentially Pareto improving.

A practical way to measure the values of inputs needed to implement a policy is the market value of the inputs. The market prices of the inputs are a function of individual preferences constrained by the distribution of wealth, thus expressing the willingness to pay for these inputs [Ref. 7:p. 59]. However, market prices can respond differently to the implementation of a policy. Analysts should consider three alternative market situations to determine the effectiveness of using market prices to measure opportunity costs. These three alternatives will be discussed below.

1. The Market Is Efficient

When the market is efficient, the purchase of inputs necessary to implement a policy will not affect the input prices in the market. Therefore, the market prices will actually express the willingness-to-pay for the inputs and it is reasonable to use the market value of the input to measure its opportunity cost.

2. The Market Is Efficient and Purchases Affect Market Prices

In situations when the purchase of goods necessary to implement a policy affects the market price of the inputs, even if the market is efficient, the price change must be taken into account in computing the opportunity costs of the input. These situations can occur, for instance, when the quantity of the inputs required is so large that purchases for the project affect the supply of the input. Therefore, the general rule is that opportunity cost equals expenditure less (plus) any increase (decrease) in social surplus, the sum of consumer surplus and producer surplus, occurring in the factor market [Ref. 3:pp 60 and 69].

3. The Market Is Inefficient

When distortions are present in the market, such as public goods, externalities, monopolies and government interventions (taxes, subsidies, regulations, etc.), opportunity costs often cannot be measured in terms of market prices. An alternative technique, called shadow pricing, should be used to estimate opportunity cost. This alternative will be the subject of future section.

F. DEADWEIGHT LOSS

When taxes are used to raise government's revenue, the price buyers pay for a good rises and the price sellers receive for a good decreases. Both buyers and sellers are worse off when a good is taxed. The reduced welfare of buyers and sellers is transferred to the government in the form of revenue raised by taxation. However, the buyers' and sellers' losses often exceed the government's gains because taxation distorts prices and makes the market to allocate resources inefficiently. The difference between the buyers' and sellers' losses and the government gains is called deadweight loss. It represents transfers from taxpayers that do not accrue to any other group in society. In principle, if a given government project is funded through taxation, the resulting deadweight loss – but not the tax revenue – should be counted as part of the cost of the project [Ref. 3:p. 57 and 62]

G. SHADOW PRICING

When market distortions and market failures lead to a divergence between market price and marginal social cost or marginal social benefit, analysts try to obtain an estimate of what the market price would be if the relevant good were traded in a perfect market. Such an estimate is called a shadow price [Ref. 3:p. 293].

The dollar value of the inputs should first be determined. If the market does not provide accurate dollar amounts to the inputs, analysts may effectively correct the existing price, if any, or attribute prices to unpriced gains and losses that the policy is expected to generate. The reader should be aware that there is no comprehensive and foolproof set of procedures for shadow pricing. Unfortunately, subjective judgment often weighs heavily in shadow pricing exercises [Ref. 2:p. 51]. Therefore, analysts should be cautious in correcting the differences between the actual and the adjusted prices. Externalities, monopolies, government intervention, public goods, and other market imperfections should be carefully examined. Analysts should base their estimations and adjustments based on these imperfections and select the best alternative to represent opportunity costs and net benefits.

H. DISCOUNTING MECHANISMS

The benefits of a policy or project are normally spread over the future. Also, some costs incurred may take place in the future. As the consequences of the policy extend over time, the net benefits of a policy have to be converted into present values. Thus, analysts need a discount rate that is appropriate from society's perspective. The discount rate that represents the society's perspectives is the social discount rate.

By definition, the net present value (NPV) of a policy equals the present value of the benefits (B) minus the present value of the Costs (C):

$$\mathbf{NPV = PV(B) - PV(C)}$$

If the policy or project will last indefinitely, benefits and costs will also accrue indefinitely during a period of time t (t = 0, 1, 2,..., n) and the social discount rate is i, then the net present value of a policy is:

$$\mathbf{NPV} = \sum_{t=0}^{n} \mathbf{(B - C)/(1 + i)^t}$$

The formula above assumes that all benefits and costs occur at the end of the period (in this case a year). [Ref. 3:p. 124]

The Social Discount Rate i is a nominal rate, incorporating the expected rate of inflation. To discount for inflation, the analyst should adjust for the rate of inflation m. Therefore, the real social discount rate (discounted for inflation) is:

$$\mathbf{r = (i - m)/(1 - m)}$$

The net present value formula becomes:

$$\mathbf{NPV} = \sum_{t=0}^{n} \mathbf{(B - C)/(1 + r)^t}$$

The estimation of the rate of inflation is another concern analysts should be worried about when performing CBA studies. Potential sources for the expected inflation rates are economic magazines, government's departments of finance/statistics, the log-term bond yield, and the Organization for Economic and Cultural Development (OECD). [Ref. 3:p. 130 and Ref. 8:p. 97] The federal government, through the Office of Management a Budget (OMB) sets its discount rate policy. OMB Circular No. A-94

provides guidelines and discount rates for CBA of government programs and will be the subject of a future section.

I. UNCERTAINTY AND SENSITIVITY ANALYSIS

Trying to predict the future, analysts make assumptions in estimating costs and benefits, discount rates, inflation rates, project's lifetime, and other key elements of the present value formula. During time, prices of inputs and outputs to the project may change as a result of shifts in preferences, technology and the actions of competitors. Some of these measures and estimates lack precision because of the variety of methods used in their quantification [Ref. 4:p. 127]. Consequently, these assumptions introduce a significant amount of uncertainty in CBA studies. Two approaches to sensitivity analysis help analysts to overcome uncertainty in CBA studies: the partial sensitivity analysis and the selective sensitivity analysis.

1. Partial Sensitivity Analysis

The purpose of sensitivity analysis is to acknowledge uncertainty [Ref. 3:p. 196]. In addition to estimating benefits, costs, and discounting rates, analysts may use a testing range for each variable to determine the resulting rank in the net benefits of a policy. In practical terms, analysts do partial sensitivity analysis, varying a single assumption while keeping all others constant, to verify the effects on the policy's net benefits.

2. Selective Sensitivity Analysis

Another practical approach to perform sensitivity analysis is the selective sensitivity analysis. The analysts select a variable that he or she feels that is both subject to error and capable of significantly affecting NPV calculations [Ref. 2:p. 142]. Then, the analyst selects the "worst and the best-case", and sometimes a "medium" value for this variable, with the purpose of determining whether the NPV reverses sign. Special attention should be dedicated to net benefits that are represented by nonlinear functions of the selected variable. In such cases, analysts should default to partial sensitivity analysis to obtain the relationship between the variable and the NPV. Regardless of the method used in sensitivity testing, the outcome of the sensitivity analysis test will point out possible areas for improvement, integrate risk and reduce uncertainty in CBA studies [Ref. 4:p. 129].

J. ALTERNATIVE ANALYTICAL TECHNIQUES

Performing CBA studies, analysts often face constraints in placing a dollar value on the relevant costs and benefits arising from the policy. As seen in Section F above, shadow pricing is one technique to estimate dollar values when the market does not reasonably define prices. However, analysts may be unwilling or unable to monetize

policy impacts, due to political or sociological constraints. Additionally, the output of a policy may be undefined and not clearly linked to preferences; thus, output cannot be measured in monetary units [Ref. 4:p. 64]. Cost Effectiveness Analysis is a common alternative used to overcome these limitations in CBA.

Cost Effectiveness Analysis (CEA) focus on technological efficiency. CEA is designed to identify the policy that would yeld the maximum output for a given cost or the least cost to achieve a given output. CEA compares alternatives on the basis of their costs and a single quantified but not monetized effectiveness measure [Ref. 3:p. 396].

CEA studies involves the measure of cost per unit of outcome effectiveness, given by the ratio of the cost of each alternative i, denoted by C_i, to the effectiveness (or benefit) of that alternative, E_i:

$$\mathbf{CE_i = C_i / E_i}$$

The most cost-effective project has the lowest cost per unit of effectiveness (CE) ratio. Thus, projects should be rank ordered from the most cost effective (lowest CE) to the less cost effective (highest CE).

Alternatively, cost effectiveness can be calculated as the ratio of the outcome effectiveness units per unit of cost:

$$\mathbf{EC_i = E_i / C_I}$$

The most cost-effective project has the highest average effectiveness per unit cost (EC). Thus, projects should be rank ordered from the most cost effective (largest EC) to the less cost effective (smallest EC) [Ref. 3:p. 197].

K. COMMON ERRORS IN CBA

The most common source of errors in CBA studies is biased behavior in estimating benefits and costs. There is considerable evidence that programs managers systematically overestimate benefits and underestimate costs [Ref. 3:p. 429]. Additionally, other potential errors do not derive from self-interest. First, analysts may omit some benefits and costs because they think they are too unlikely to occur. The omission error is very likely to occur when there is technical disagreement about the impacts of the project.

Second, double counting frequently occurs when analysts count benefits and costs that arise both in primary and secondary markets. Conceptually, benefits and costs arising in secondary markets should be disregarded. Changes in secondary markets result

mainly from relative price changes in both primary factor and commodity markets and involve only redistributive outcomes; therefore, the consensus in the literature is that they should be avoided [Ref. 4:pp. 82 – 83].

Third, analysts count on forecasting methods to estimate costs, benefits, inflation, etc. To the extent that the future is not perfectly mirrored by the past, forecasting will be generally in error to some degree [Ref. 9:p. 122]. In addition, uncertainty imposes biased estimates of costs and benefits, affecting individual valuation of "good" and "bad" events. In general, people underweight bad events and overweight good events.

Finally, events are often observed, recorded or interpreted inaccurately [Ref. 3:p. 431]. The inaccurate measurement of events tends to spread over several studies, as data of one project is used to support estimates of other projects. In reality, accurate data is scarce and not sufficient to support the wide demand for CBA studies.

L. OMB CIRCULAR NO. A-94

First issued in 1972, the Office of Management and Budget (OMB) Circular No. A-94 is the major document regulating the application of CBA to U.S. federal government programs. The purpose of the circular is "to promote efficient resource allocation through well-informed decision-making by the Federal Government." [Ref. 10] The scope of the circular is broad and applies to all analyses submitted to OMB in support of budget programs. The circular regulates CBA and CEA analysis of Federal programs and policies, regulatory impact analysis, analysis of decisions whether to lease or to purchase, and asset valuation and sale analysis, with a few exceptions.

OMB defines CBA as "a systematic quantitative method of assessing the desirability of government projects or policies when it is important to take a long view of future effects and a broad view of possible side effects." The circular establishes that the criterion to justify a policy or program under economic principles is the net present value. This definition matches the theoretical understanding of CBA. As seen in Section B, the major components of the theoretical definition of CBA – an analytical framework and the necessary monetary valuation of benefits and costs – are also present in OMB definition.

Similarly, costs are interpreted in terms of opportunity cost, disregarding sunk costs, and benefits are measured in terms of willingness-to-pay and recorded only in primary markets, disregarding realized benefits and secondary effects.

Slightly inconsistent with the theoretic approach is OMB's definition of the real discount rate, adjusted to eliminate inflation. According to OMB, "the real discount rate (r) can be approximated by subtracting the rate of inflation (m) from the nominal interest rate (i)," so:

$$r = i - m$$

This calculation of the real discount rates differs slightly from the theorectically correct calculation presented in Section G by **1/(1 – m)**. The difference between the calculations using the theoretic and the OMB approach are mathematically insignificant. However, the difference grows as the project or policy lasts longer. Table 5.1 shows the arithmetic and the percentile difference in the NPV calculation of a hypothetical project with an annuity of $1,000 during a 10-year period using the theoretic and the OMB approach. The difference increases from 0.24 percent in year one to 2.33 percent in year 10 and represents a total of 1.03 percent. In projects involving large amounts of money and with long a life-cycle, this difference might be significant. Figure 5.1 graphically represents the slope in which the percentile difference is rising during the 10-year period.

Rate					
Nominal	10%				
Inflation	4%				
	Theoretic	OMB			
Real	6.25%	6.00%			
Year	Annuity	Theoretic	OMB	Differnce	%
0	$1,000.00	$ 1,000.00	$ 1,000.00	$ -	0.00%
1	$1,000.00	$ 941.18	$ 943.40	$ 2.22	0.24%
2	$1,000.00	$ 885.81	$ 890.00	$ 4.18	0.47%
3	$1,000.00	$ 833.71	$ 839.62	$ 5.91	0.70%
4	$1,000.00	$ 784.66	$ 792.09	$ 7.43	0.94%
5	$1,000.00	$ 738.51	$ 747.26	$ 8.75	1.17%
6	$1,000.00	$ 695.07	$ 704.96	$ 9.89	1.40%
7	$1,000.00	$ 654.18	$ 665.06	$ 10.88	1.64%
8	$1,000.00	$ 615.70	$ 627.41	$ 11.71	1.87%
9	$1,000.00	$ 579.48	$ 591.90	$ 12.42	2.10%
10	$1,000.00	$ 545.39	$ 558.39	$ 13.00	2.33%
Total	-	$8,273.69	$8,360.09	$86.40	1.03%

Table 3.1. Discount Rate Comparison under the Theoretic and OMB Approach.

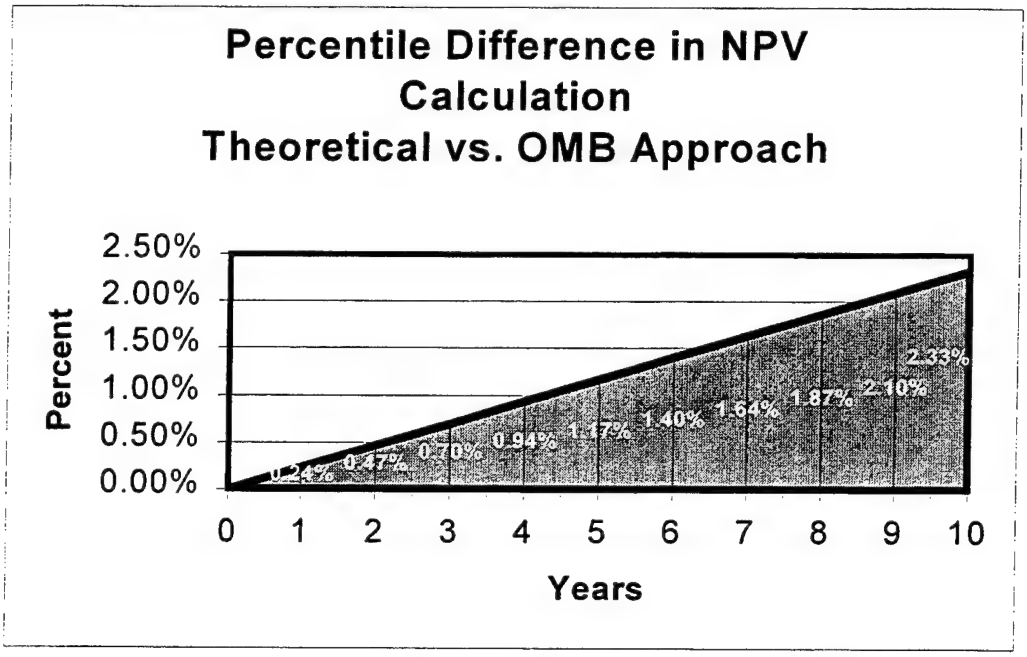

Figure 3.1. Percentile Difference in The NPV Calculation under the Theoretic and the OMB Approach.

The Circular establishes which discount rates are to be applied in CBA and CEA studies. In CBA studies, the real discount rate currently mandated is 7 percent, while CEA studies should use the real Treasury borrowing rate:

> Base-Case Analysis. Constant-dollar benefit-cost analysis of proposed investments and regulations should report net present value and other outcomes determined using a real discount rate of 7 percent.
>
> Cost-Effectiveness Analysis. Analyses that involve constant-dollar costs should use the real Treasury borrowing rate on marketable securities of comparable maturity to the period of analysis. This rate is computed is computed using the Administration's economic assumptions for the budget, which are published in January of each year.

OMB annually publishes an updated table of discount rates based on the expected interest rate for the first year of the budget forecast in appendix to Circular No. A-94. The OMB Circular No. A-94 is the basic document that Federal government analyst should follow to perform CBA studies.

M. CHAPTER SUMMARY

This chapter presents the main issues concerning the use of CBA. It assumes that CBA is a technique to estimate and evaluate the net benefits associated with alternatives for achieving public goals. It introduces the idea of allocative efficiency and how it is

related to willingness-to-pay and opportunity cost, in efficient and inefficient markets. Shadow pricing is the technique used to overcome market distortions. This chapter also describes the discounting mechanisms, the influence of uncertainty in CBA studies and how sensitivity analysis deals with uncertainty. We discuss CEA as an alternative technique to be used when placing a dollar value to relevant costs and benefits is difficult. Common errors in CBA studies derive from biased behavior, omission errors, double counting, forecasting, and inaccurate event interpretations. Finally, we discuss the OMB Circular No. A-94 and how it influences the application of CBA studies in federal agencies. In the next chapter, we will use the concepts described here to present and analyze the software and automated tools used in DOD to help analysts to perform CBA studies.

IV. COST-BENEFIT SOFTWARE AND AUTOMATED TOOLS IN THE DEPARTMENT OF DEFENSE

A. INTRODUCTION

This chapter identifies the main DOD regulations that apply to CBA studies and how they influence related studies in the DOD. We also list the organizations involved in conducting CBA. Then, we discuss the existing systems, software and automated tools available to DOD analysts to enhance the performance of CBA studies. Initiatives in non-DOD federal agencies are likewise listed to allow the reader to have a broader understanding of the uses of CBA in the federal government.

B. COST-BENEFIT ANALYSIS RULES AND REGULATIONS

1. DOD Instruction 7041.3

Besides OMB Circular No. A-94, the primary document regulating economic analysis studies in DOD is DOD Instruction 7041.3 (DODI 7041.3), published in 1995. This instruction creates the Defense Economic Analysis Council (DEAC), which has the following responsibility:

> That Council shall encourage DOD-wide application of the concepts contained in this Instruction in the planning, programming and budgeting processes. It shall develop DOD-wide standardized format and documentation requirements and identify support tools to insure consistent, complete economic analysis submission. [Ref. 14, Enclosure 2]

The description of the responsibilities of the DEAC ensures DOD's commitment to standardize procedures and, furthermore, to develop tools to ensure complete economic studies. The statement represents the basis for the development of software and automated tools designed to help analysts to perform CBA studies. The instruction applies to all DOD components and is prescribed to the evaluation of decisions about the acquisition of:

- Real property or other assets, such as by lease or purchase.
- Automated information systems.
- Weapons systems and weapons systems support.

Exceptions are energy management programs, commercial activities, water resources projects [Ref. 14].

However, DODI 7041.3 does not apply to programs or projects that fall under OMB Circular No. A-94. An additional clause of exception states:

> 2.5.4. Programs or Projects that involve Costs or Quantifiable Benefits primarily external to the Federal Government. Analyses for those types of programs or projects are addressed as 'public investment and regulatory analyses' under OMB Circular A-94. 'Economic analysis' in this Instruction refers to programs and projects with costs and benefits that are primarily internal to the Federal Government. [Ref. 14]

The exception in the instruction avoids guidance conflict with the OMB circular by clearly defining jurisdiction. Second, the instruction differentiates between internal and external effects related to the DOD environment. That differentiation might be the reason for the tendency of treating benefits of DOD programs and projects in terms of cost avoidance or cost savings, as we will see in future sections.

2. Army Regulations

a. Department of the Army "Economic Analysis Manual"

The Army "Economic Analysis Manual" is proposed to provide basic frameworks of methodologies and procedures for helping analysts in policies and cost analysis studies. It gives an overview of the cost analysis process, methods and techniques. The Manual focuses basically on cost analysis, cost estimates, life-cycle cost, rather than on full-scale CBA studies. [Ref. 21] However, the manual clearly identifies principles for assessing the cost side of some CBA studies.

b. "Army Regulation 11-18"

This regulation establishes responsibilities and policies for the Army's Cost and Economic Analysis Program. The program establishes that the Army will "provide timely and sufficient cost and economic analysis to support the effective allocation and management of resources for Army programs" and "develop and maintain cost and economic analysis as effective and efficient tools for decision-making." The program establishes assumptions, determine the methods for collecting data on costs and benefits, guides present value comparison of costs and benefits and sensitivity analysis. The program indicates that ECONPACK software is the automated tool to support economic studies. [Ref. 22]

c. "Automated Information Systems Economic Analysis Handbook"

The Army's "Automated Information Systems (AIS) Economic Analysis Handbook" provides a comprehensive approach to understanding and preparing financial analysis for the life-cycle management of automated information systems. It defines economic analysis as:

> An economic analysis provides a systematic method for studying problems of choice. Alternative ways to satisfy a requirement are studied by evaluating the quantifiable costs and benefits of each alternative. [Ref. 23]

This definition contains the same elements of the theoretic definition of CBA presented in Chapter III.

The Handbook provides an extensive list of cost elements. Also, it identifies three potential types of benefits – direct cost savings, efficiency/productivity increases, and nonquantifiable output measures. [Ref. 22] Such treatment to benefits is consistent with the DODI 7041.3 approach mentioned in section B.1. ECONPACK is the software recommended in the AIS Handbook to perform the CBA, or economic analysis, of automated information systems.

3. US Navy "Economic Analysis Handbook"

The Navy's "Economic Analysis (EA) Handbook" is an extensive manual to assist analysts and decision-makers in preparing, interpreting and applying cost-benefit analysis. "It is a practical, 'how to do it' guide rather than a theoretical one." [Ref. 24] The "EA Handbook" defines economic analysis as:

> A systematic approach to the problem of choosing how to employ scarce resources to achieve a given objective(s) in an effective and efficient manner. [Ref. 24]

It also states that EA is "often referred to as cost/benefit analysis."

The approach to determine the benefits of a project suggested in the Handbook is peculiar and reflects the understanding of benefits given by DODI 7041.3. The book states:

> The principal benefit from a military project is the completion of a stated objective. Since this is a benefit common to all the alternatives, its inclusion in the calculations will not affect the raking of the alternatives. Consequently, quantification of the principal benefit is unnecessary. [Ref. 24:p. 2-6]

Benefits should be measured in terms of willingness-to-pay, the positive amount of money individuals are inclined to pay for the policy or project. Thus, even if the project goals are the same, individuals might be willing-to-pay different amounts of money for different projects, making their benefits differ substantially.

Nonetheless, we understand that benefit estimation represents a laborious step in CBA studies. In practice, the DOD approach to benefits can be understood as a simplified way of eliminating expensive, complicated and sometimes inaccurate estimation techniques. Hence, this thesis hereafter will consider the DOD approach to CBA studies to be the acceptable approach under the current legislation.

The discount rate prescribed in the Handbook follows the theoretical rule for discounting for expected inflation, differing slightly from the OMB calculation. ECONPACK is the preferred software to perform economic analysis calculation. Recommending format for documentation and format of CBA studies, the Handbook states:

> As you will see, ECONPACK addresses the same information (input and output data) as the previously mentioned 'accepted' formats. In addition, however, ECONPACK has additional capabilities for saving you time by being able to generate various reports and perform sensitivity analysis. [Ref. 24]

Compared with the instructions and manuals mentioned in previous sections, the Navy's Economic Analysis Handbook can be considered the most extensive, detailed, and beneficial manual available to DOD personnel immersed in CBA studies.

4. Other Services

The other military Services rely on the OMB Circular A-94 and DODI 7041.3 to guide CBA studies. Major instructions or norms regulating this subject were not found.

C. DOD AGENCIES THAT CONDUCT COST-BENEFIT ANALYSIS

Steered by the OMB Circular No. A-94 and DODI 7041.3, several agencies throughout DOD were created or had missions modified to deal with cost-benefit analysis. As CBA studies became required, DOD agencies needed to rely on more accurate estimates and techniques to support their budgetary process. The task of performing accurate studies is difficult. Specialists in the issue are required and resources to support the CBA methodology, including software and automated tools, are scarce. Therefore, the proclivity in the DOD environment is to concentrate the efforts attached to CBA in specific organizations. These organizations support analysts with knowledge,

tools, methodology, and data for CBA studies throughout DOD. They provide subsidies to perform CBA studies and, sometimes, perform the studies themselves.

The main organizations in the DOD environment dealing with CBA are:

- Office of the Under Secretary of Defense – Comptroller
- Naval Center for Cost Analysis
- Naval Facilities Engineering Command
- Army Cost and Economic Analysis Center
- US Army Corps of Engineers - Headquarters
- Air Force Cost Analysis Agency

A comprehensive list of DOD Organizations in the CBA business and their Internet addresses are provided in Appendix A.

D. CBA TOOLS AND AUTOMATED SYSTEMS IN THE US ARMY

1. Economic Analysis Package - ECONPACK

ECONPACK is an economic analysis software package available to analysts throughout DOD and government agencies structured to support CBA and CEA studies required by OMB Circular No. A-94. ECONPACK is a comprehensive program incorporating economic analysis calculations, documentation and reporting capabilities. It is the main CBA software used in DOD. The system will be the subject of extensive analysis in Chapter V.

2. Tri-Services Automated Cost Engineering System – TRACES

TRACES is an Army initiative intended to link all automated cost engineering systems and their associated data bases within DOD. The entire system seeks to provide a user-friendly cost engineering platform in a standard environment that will provide the cost engineer the tools to prepare, review, and maintain all types of cost estimates. Software for scheduling construction projects is also linkable to TRACES.

TRACES provides cost engineers with tools to prepare budgetary estimates in support of the DoD military program and the Corps of Engineers Civil Works program. TRACES modules are used for construction cost estimating for Military Programs and Civil Works Projects. The US Army Corps of Engineers – Engineering and Support Center DD1391 module, housed on the Programming, Administration, and Execution (PAX) System mainframe supports TRACES. [Ref. 11]

3. Army Military-Civilian Cost System - AMCOS

The Army Military-Civilian Cost System is a user-friendly, PC-based tool used to support military and civilian cost estimation. It is fully interactive, providing help screens and offering extensive menus for easy operation.

AMCOS is a database of active, reserve, and civilian manpower data developed for accuracy and flexibility of manpower cost estimation. The U.S. Army Cost and Economic Analysis Center (USACEAC) is responsible for operating, maintaining, updating, and modifying the AMCOS database, which is used to provide military and civilian cost estimates for acquisition, installation operations, force/unit costing, and a variety of cost analysis requirements.

In addition, the AMCOS Homepage offers extensive resources to support personnel cost estimation within the Army. Detailed information regarding the AMCOS software, options to download and view AMCOS personnel costs, examples of different ways to apply AMCOS personnel costs, and resources to help using AMCOS software are available at the homepage.

AMCOS main applications include estimating:

- The costs of manning a new weapons system over its life cycle.
- The manpower cost tradeoffs of alternative weapons systems during force modernization.
- The cost of adding new manpower positions to the force structure.
- The cost-effectiveness of active/reserve/civilian manpower mix.
- The incremental impact to the budget of changes in personnel policy or compensation. The Programming, Administration, and Execution (PAX) System mainframe located at the USACEAC houses AMCOS. [Ref. 12]

E. CBA TOOLS AND AUTOMATED SYSTEMS IN THE US AIR FORCE

1. Parametric Cost Engineering System - PACES

PACES is an integrated PC-based cost certification/estimating system that is intended for use by the military engineering community, as well as contractors working on Military Construction Program projects. The parametric approach differs from traditional cost estimating methods by allowing the user to input a minimum amount of information to create a cost estimate, with model default quantities based on similar projects and experienced engineering assumptions. Predefined and documented engineering relationships link the primary parameters to detailed engineering quantities. In PACES, these quantities, as well as most other model assumptions, can be changed by the user at various places within the model to reflect project specific conditions. The use

of the parametric model helps to avoid the errors and omissions that are common in traditional cost estimating procedures, particularly during planning and early design phases.

PACES is accompanied by a computer-based multimedia learning system, PACES Computer Based Training System (PACES-CBT) was developed for U.S. Government employees and their contractors who use the PACES software to prepare cost estimates for conventional and environmental building project designs. The system is self-teaching and enables users to install it on their personal computer and train themselves when needed. The system provides information on general construction cost engineering principles, as well as basic and detailed training elements for the PACES software. PACES99, the new Windows based version of the system is distributed by the Air Force Civil Engineering Support Agency (AFCESA) by user's request. PACES-CBT can be downloaded from the AFCESA website. [Ref. 13]

2. Full Cost Visibility and Associated Utility Module - FCV/UM

Full Cost Visibility provides a means to collect and report all costs to accomplish work and collect full reimbursement from work orders. The main benefit is a more accurate cost accounting and reporting system. This provides accurate facility costs to Air Force (AF) customers, thus providing an incentive to become more cost conscious and save scarce resources.

DOD funding initiatives require support costs to relate directly to the operational mission and require a businesslike approach to operational and support costs [Ref. 14]. These initiatives, which include FCV, represent a major change in cost management philosophy.

FCV/UM maintains a default database by interfacing with the Real Property Records for every facility on the base. This information distributes the costs on work orders among all customers in the facility. FCV/UM assists the utility/energy manager in calculation and distribution of utility costs for all customers. By inputting consumption data and the utility sales rate, UM becomes a standardized tool to provide engineered estimates with tracking and trend reporting. The utility program may be used alone or in conjunction with the rest of FCV. Both modules are optional and each command decides what is necessary for the bases under their jurisdiction [Ref. 15].

F. CBA TOOLS AND AUTOMATED SYSTEMS IN THE US NAVY

1. Cost of Manpower Estimating Tool - COMET

COMET is PC-based software developed to enable defense contractors and Navy cost analysts to estimate personnel-related costs associated with the acquisition process. The software incorporates parameters from the Navy Center for Cost Analysis (NCCA) "Cost of a Sailor" studies and provides users with Navy manpower cost estimates of active, reserve and civilian components. COMET provides the analyst with a tool to make decisions about manpower versus hardware tradeoffs. COMET costs are customizable, allowing the user to include only costs pertinent to the analysis. In addition, costs are comprehensive, including both the direct costs of manning billets (i.e., the pay and allowances and retirement pay accrual received by the sailor or civilian serving in the billet) and the variable indirect costs associated with acquiring, training, locating and supporting those personnel. Costs estimates are granular, varying across skills, pay-grade and geographic location for civilians.

COMET is divided into three functional parts: (1) individual billet data; (2) final cost file creation/modification; and (3) life cycle cost modeling. Individual billet data and individual average costs per pay grade may be viewed down to the level of specific variable costs. Final cost file creation/modification allows users to create a final cost estimate using assumptions other than the COMET defaults. These files can be used by analysts in creating a variety of scenarios in the modeling part.

In the COMET model, costs vary according to grade and skill, allowing analysts to measure the impact of additional manpower requirements on total navy costs more accurately. Often, the cost variation of changes in requirements is only captured through the measurement of the direct costs. By capturing the variable indirect costs, the model reveals the differences among different skills. COMET also allows analysts to measure hardware and manpower tradeoffs. The cost difference generated by substituting pieces of hardware for skilled labor as well as the costs generated by substituting one type of labor for another can be measured to provide an accurate estimate of manpower costs. COMET is distributed by the NCCA in diskettes and CD-ROM or can be downloaded from the NCCA's website [Ref. 16].

2. Naval Visibility and Management of Operating and Support Cost Database – VAMOSC

VAMOSC displays naval operating and support (O&S) costs and related information (e.g., operating hours, manning, etc.) about ships, aircraft, ordnance and tracked/wheeled vehicles. Depending on the specific commodity type and system, this

Oracle relational database contains up to 15 years of data presented by fiscal year or by alternative hierarchical cost element structures, including expenditures or obligations collected annually from 125 different sources.

Historically, VAMOSC data was used predominantly by the Navy, the Marine Corps, and industry cost analysts to develop the O&S cost portion of life cycle cost (LCC) estimates for future weapon systems. Today, the VAMOSC database is an integral part of Department of Navy efforts to better understand and reduce the Total Ownership Cost (TOC) of legacy and future weapon systems. Specifically, VAMOSC is being used to develop the O&S portion of TOC baselines and to identify significant cost elements that might represent cost reduction opportunities. However, it is widely recognized that the VAMOSC database requires significant improvements before it can fully satisfy the demands of all users. Efforts are currently underway to increase the breadth (i.e., weapon system and cost element coverage), depth (i.e., cost element visibility), timeliness and accessibility of VAMOSC data.

The Naval VAMOSC database, operated and maintained since 1992, is currently available to government and industry users by several means. Frequent users query the Oracle relational database directly using either web browser software or client/server software [Ref. 17].

3. Affordable Readiness Cost Model - ARCM

The Affordable Readiness Cost Model is a comprehensive tool designed to assist in the preparation of an affordable readiness initiative proposal. The model has five different modules that allow users to address a wide range of initiative types. These can aid users in organizing the cost elements and cost estimating factors, and in preparing an estimate of the potential cost avoidance attainable with initiative implementation.

The system provides a User Manual with a complete description of the model's capabilities and provides instructions for installation and use. The software and the user's manual can be downloaded from the Naval Air Systems Command (NAVAIR) website. [Ref. 18]

4. Historical Aircraft Production Cost Archives - HAPCA

The HAPCA database was developed by the NAVAIR cost department in the 1980's to support aircraft production and investment estimating. The cost department collected actual cost incurred at the budget categories and Navy aircraft quantity information for all of the aircraft production programs executed by NAVAIR.

This database contains history on a wide range of aircraft programs. The database can be sorted by aircraft type (i.e., Fighters, Attack, Trainers, etc.), type/model/series

(T/M/S), contract number or procurement fiscal year. Access to HAPCA database should be requested to the NAVAIR Cost Department (AIR-4.2) database administrator. [Ref. 18]

G. INITIATIVES IN NON-DOD FEDERAL AGENCIES

1. Building Life Cycle Cost Computer Program – BLCC

Developed by the Department of Commerce, National Institute of Standards and Technology, the Building Life-Cycle Cost (BLCC) is a PC-based computer program that provides comprehensive economic analysis of proposed capital investments that are expected to reduce long-term operating costs of buildings or building systems. It is especially useful for evaluating the costs and benefits of energy conservation projects in buildings. Economic measures, including net savings, savings-to-investment ratio (SIR), adjusted internal rate of return (AIRR), and years to payback can be calculated for one alternative relative to the base case or to another related alternative. BLCC can perform LCC analysis for the following analysis types:

- Energy Conservation Projects
- Projects subject to OMB Circular A-94 Guidelines
- Projects with tax analysis
- Owner-occupied houses (limited tax deductions)
- MILCON - Military Construction: Energy-related Projects
- MILCON - Military Construction: Non-energy-related Projects

BLCC can be bought via Internet in the software's website. The software is delivered on two 3 ½ inches 1.44 MB diskettes. The operational system used is DOS. [Ref. 19]

2. NASA Space Operations Cost Model - SOCM

NASA's Space Operations Cost Model (SOCM) study team is currently developing a suite of tools to predict space mission operations costs for future NASA projects. The estimating methodology is based on a mix of parametric estimating relationships derived from collected data and constructive approaches capturing assessments of advanced technology impacts and reflecting experience from current mission planning teams. The study team includes cost, technical, and programmatic experts from each NASA Center.

At completion, SOCM will include modules for:

- Planetary and Earth Orbiting robotics science missions
- Orbiting Space Facilities
- Launch/Transportation Systems
- Human Spaceflight (Lunar/Mars) missions

Currently, SOCM Version 1.0 is available covering Planetary and Earth Orbiting robotics science missions. This version follows more than 10 rapid prototypes, each incorporating feedback collected from the previous version user community. The model estimates post-launch Mission Operations & Data Analysis (MO&DA) staffing and cost requirements and includes cost relationships for several Space Operations Management Office (SOMO) services (tracking network costs and others). SOCM Version 1.0 can be downloaded from the software's website. [Ref. 20]

H. CHAPTER SUMMARY

In this chapter we examined DODI 7041.3 and other DOD regulations framing CBA studies. We identified the agencies involved in CBA studies. Finally, we listed the software and automated tools available to DOD analysts enhance CBA studies accuracy. We showed that a series of initiatives provide a great source of data and information concerning to costs. By reading the list of tools and their characteristics, readers will become aware of what is currently available in DOD to make CBA studies more precise. The next chapter will examine ECONPACK and use the tool to perform concrete examples of recent DOD CBA studies.

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V. THE US ARMY "ECONOMIC ANALYSIS PACKAGE" - ECONPACK

A. INTRODUCTION

Chapter IV listed the software and automated tools currently available in DOD to support CBA. This chapter provides an in-depth examination of the US Army "Economic Analysis Package" – ECONPACK, the most widely adopted automated analytical tool in DOD environment. First, we present the economic theory that ECONPACK uses to frame economic studies. We also analyze the software's strengths and weaknesses in supporting CBA. Finally, we use ECONPACK to reproduce two recent studies with the objective of verifying its adequacy as a CBA supporting tool.

B. ECONPACK'S ECONOMIC ANALYSIS PROCESS

Designed to address the question of which of two or more alternatives is the most cost effective way to meet an objective, ECONPACK primarily supports cost effectiveness studies. It considers military construction analyses as cost-effectiveness economic analyses. Alternatives are considered that produce similar benefits but different costs. Thus, identifying the least costly alternative is the fundamental factor to determine the most economical solution to meet a given objective. The built-in system's help addresses this point:

> The optimal (or economically best) solution is to select the alternative which provides the least cost solution. Military construction EAs are cost effectiveness types, meaning the alternatives have the same benefits but different costs; the primary benefit should be the same. In a situation of this sort, the least costly alternative is the most economical. [Ref. 26]

ECONPACK divides the economic analysis process in seven steps to ensure the completeness of the study:

- Establish and state objective
- Identify alternatives
- Formulate assumptions
- Determine costs and benefits
- Compare alternatives

- Perform sensitivity analysis
- Report results and recommendations

A schematic representation of the seven steps in ECONPACK is presented in Figure 5.1.

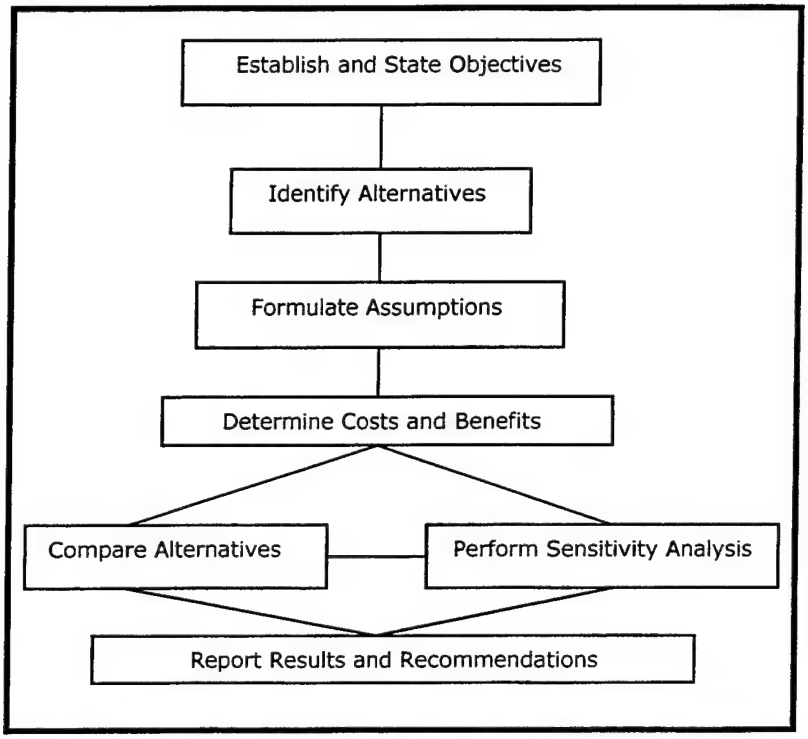

Figure 5.1. Economic analysis steps in ECONPACK.

1. Establish and State Objectives

The first step is dedicated to establish the objective – the result or outcome to be achieved; that is, the objective states what the alternatives are to accomplish. The statement of the objective should clearly define and quantify to the extent possible the function to be accomplished. A quantitative statement of the objective is beneficial because it provides an explicit method of testing of the adequacy of possible alternatives. Establishment of the objective is often a policy matter, which lies beyond the scope of the individual responsible for an EA. [Ref. 26]

2. Identify Alternatives

After the objective is established and properly stated, the next step is to consider all reasonable ways of satisfying that objective. For a possible alternative to be considered reasonable, it should be consistent with regulations and legal requirements. It must also meet the actual goal or objective. [Ref. 26]

3. Formulate Assumptions

EAs are future oriented. They are focused on current decisions, which have benefit and cost implications for future years. To the extent possible, EAs should be based on objective "facts." Since the future is not completely known with certainty, it is often necessary to make assumptions in order to proceed with an EA. Examples of assumptions include: the physical life of an asset, the level or extent of future requirements for a particular function and the usefulness of a facility after the present objective is fulfilled. It is often possible to base these assumptions (or "estimates") on historically or technically factual information. [Ref. 26]

4. Determine Costs and Benefits

This step is often considered the most difficult and time-consuming. The analyst must decide what data are needed, how the relevant data are to be collected and documented, and when the data in-hand are sufficiently reliable to be used in the economic analysis. The technique used in ECONPACK to estimate the benefits of a project is consistent with the DODI 7041.3 and with the US Navy Economic Analysis Handbook. ECONPACK states the benefits of a project as:

> The principal benefit to be derived from a military project is fulfillment of the stated objective. Since this is a benefit common to all viable alternatives, its inclusion in the EA calculations would not affect the ranking of alternatives. Consequently, dollar quantification of the major benefit is unnecessary. Emphasis is therefore placed on the costs of the alternatives. [Ref. 26]

Therefore, quantifiable benefits other than meeting the stated objective of each alternative are treated as cost offsets for that alternative and measured as cost avoidance.

Costs and benefits must be determined for the entire useful life of the project. This is known as life cycle costing. Timing is important in investment decision-making as estimates are needed for the year in which a cost is to be incurred or a benefit is to be received. If actual dollar amounts are known, it should be realized that assumptions might be necessary with respect to timing. The costs and benefits associated with each alternative under consideration should be quantified whenever possible, so they may be included in the EA calculations. When quantification is not possible, the analyst should still attempt to document significant non-quantifiable costs and benefits so that these may be considered when comparing alternative courses of action. [Ref. 26]

5. Compare Alternatives

This step focuses on recommending the most economically attractive alternative. The comparison of the costs and benefits is the central focus of the analysis. The purpose of this step in the EA process is to establish a ranking of alternatives based on the costs of and benefits derived from each proposed alternative. [Ref. 26]

6. Perform Sensitivity Analysis

This step deals with uncertainty. A sensitivity analysis is performed when there are large uncertainties about costs, timing, or other input data, or when the result of the comparison steps does not reveal a clearly superior alternative. A sensitivity analysis allows the analyst to engage in a "what if" process to determine how critical the particular assumptions used. Selected parameters or assumptions are allowed to vary to determine whether or not a change in costs is likely to lead to a change in ranking of alternatives.

ECONPACK performs sensitivity analyses by varying expense items specified by the analyst to see if the NPVs of the alternatives reverse ranking due to the changes. Two alternatives may be selected for the sensitivity analysis and the analyst sets a lower and an upper limit on the percentage that the expense items may vary. By including the results of the sensitivity analysis in the final study, analysts assure the decision maker that uncertainty have been considered. [Ref.26]

7. Report Results and Recommendations

The last step focuses on the document for the decision maker to use in deciding on the appropriate use of resources. The structure of the report should begin with a summary of the analysis, including recommendations based on the content of the analysis. The recommendations are an important input into the final decision-making process.

It is important to consider non-quantifiable benefits and costs as well as the quantifiable ones, which enter into the calculations. Following the recommendations, the report should provide a step-by-step explanation of the basis for the recommendations. This explanation should ideally follow the structure of the economic analysis process itself. That is, it should include: statement of objective; definition of alternatives; explanation of assumptions; cost and benefit data and sources; comparative ranking of alternatives based on costs and benefits; and sensitivity analysis results. [Ref.26]

C. TYPES OF ECONOMIC ANALYSIS

ECONPACK categorizes economic analysis into two separate types: *primary* economic analysis, also referred to as Type I analysis, and *secondary* economic analysis, also referred to as Type II analysis. The structure of the economic analysis is similar whether the study being produced is primary or secondary. However, budgetary effects,

report formats, and certain computations differ depending on the analysis type. [Ref. 27:pp. 1-9]

1. Primary Economic Analysis (Type I)

A primary economic analysis is designed to determine whether an existing situation or procedure should be changed in some way to take advantage of dollar savings available by adopting some other situation or procedure. In a primary analysis, the purpose of comparing alternatives with the current method of operation is to determine whether the existing situation or procedure should be changed to produce savings. This type of analysis is used to determine if there is an economic justification for changing the present way of doing business. Direct comparison is made between each new alternative and the status quo. If two or more new alternatives are being considered, each is compared directly to the status quo. The one with the lowest present value is considered the economically preferred solution. [Ref. 27:pp. 1-10]

2. Secondary Economic Analysis (Type II)

A secondary economic analysis is used to determine which of two or more alternatives would most economically fulfill an objective, which is not being currently fulfilled. The fundamental difference between Type I and Type II analysis is the absence of the status quo alternative in Type II. Since the objective is not being fulfilled, the focus of Type II analysis is on the net cost of each alternative. The economically preferred alternative does not result in absolute savings; rather it represents the least-cost alternative relative to other possible alternatives. The alternative presenting the lowest net cost of achieving the given objective is considered the economically best solution. [Ref. 26 and 27:pp. 1-9] Note that this approach is much closer to cost-effectiveness analysis than to true cost-benefit analysis.

D. DISCOUNTING

ECONPACK uses standard discounting procedures to adjust dollar amounts of benefits and costs incurred at different points in time. The calculations are consistent with the theoretical approach stated in Chapter III. ECONPACK's general formula for discounting a single cost occurring in the future is:

$$PV = \sum_{t=0}^{n} C/(1+i)^t$$

Where:

PV is the present value of the cost;

C is the actual value of the cost when it is incurred in time t;

i is the interest rate; and

t is the duration of the project. [Ref. 27:pp. 1-14]

ECONPACK also has the capability to discount for inflation. The software differentiates between current dollar analysis and constant dollar analysis. Current dollar analysis implies that the full effects of inflation should be applied to all costs. To calculate the interest rate discounted for inflation in a current dollar analysis, ECONPACK uses the OMB Circular A-94 procedure as discussed in Section III-K.

Constant dollar analysis is used when certain costs are expected to experience a substantially different rate of inflation than the general economy. Users can apply a differential inflation factor to the costs they expect to behave differently. The analysis is performed in terms of a particular baseline year and a specific discount rate, discounted for inflation according to OMB Circular A-94, is applied to this baseline year. [Ref. 27:pp. 1-15]

E. ECONPACK APPRAISAL

First released under a Microsoft Disk Operating System (DOS) platform, ECONPACK became the most widely used software throughout DOD to prepare economic analysis. Due to the obsolescence of the DOS platform and to the rapid growth of Microsoft Windows-based systems, a new Windows version, ECONPACK Ver. 2.0, was developed. Appendix B provides a list of the enhancements added in the new version. This section discusses the strengths and weaknesses of ECONPACK as an automated tool in the application of cost-benefit principles.

1. Software Capabilities

ECONPACK is a computer package that integrates economic analysis calculations, documentation and reporting capabilities. The software combines spread-sheet (calculations and graphs) and text processing capabilities to ease the process of preparing economic analyses. Standardized methodology and calculations allow non-economists to use the software to prepare complete and well-documented studies in accordance with OMB and DOD guidelines.

2. Built-in Help Program

ECONPACK is equipped with a comprehensive built-in help program. The Help program provides context sensitive help, functional assistance, economic theory, as well as policy and regulation information. A search capability is also available to facilitate finding the information needed.

ECONPACK Ver. 2.0 Help program substitutes the early DOS Version 4.0 User's Manual. In spite of its completeness, the manual was difficult to update and represented additional costs related to updating, printing and shipping to users. The Help program is

available to every user and is automatically update when a new version is released, easing the burden of distribution.

The Help program incorporates all the features existing in the previous user's manual. The information is presented comprehensively and is easy to find. Frequently asked questions, economic analysis theory and glossary, the methodology supported, the Version 2.0 new features, and information related to training and problem solving are all included in the help. Additionally, inexperienced users can benefit from the system's guided tour that explains all the steps necessary to use ECONPACK. Figure 5.2 shows the existing features in the built-in help program.

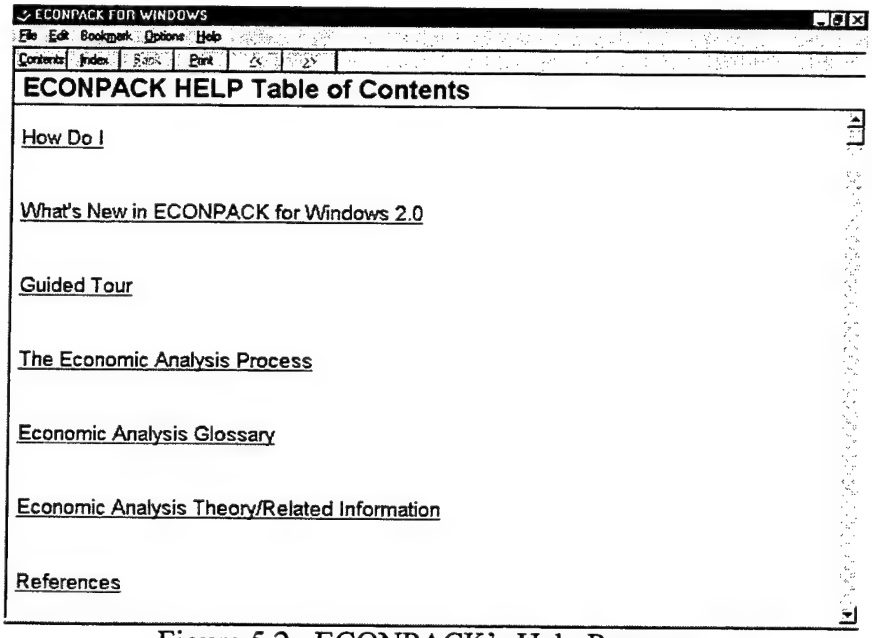

Figure 5.2. ECONPACK's Help Program.

3. Downloading and Uploading Capabilities

ECONPACK supports the transferring of economic analysis data from a personal computer to the US Army Corps of Engineers – Engineering and Support Center DD1391 module, housed on the Programming, Administration, and Execution (PAX) System mainframe. PAX mainframe supports TRACES, the Army's effort to integrate all DOD cost engineering system described in Section IV-D-2. The download feature establishes a connection to the PAX System for transferring an economic analysis from a DD1391 Form to a personal computer. During the download, the data is converted to a format usable in ECONPACK. The upload feature establishes a connection to the PAX System for transfer of economic analysis data from a personal computer to the Economic Analysis section of an existing DD1391 Form. Uploaded files are zipped and stored in

the ECONPACK database on the mainframe. [Ref. 26] TRACES users, in the future, will be able to share those files and benefit from the availability of historical data.

4. Specificity to MILCON Projects

ECONPACK is primarily designed to support military construction (MILCON) projects. All terminology, theory and examples are framed to support life-cycle cost analysis, implying the comparison of all differential costs associated with alternatives over time of MILCON projects. Examples of the specificity of the software taken from the help program follows:

> For example, the expense item "utilities" may be entered in place of the four expense items "water, gas, sewer, and electricity," and the annual cost would reflect the sum of the four individual utility costs.
>
> Possible alternatives have been grouped into nine types listed below, which represent the most typical alternatives considered for military construction EAs.
>
> Nevertheless, the cost of current operations may need to be included in the economic analysis to account for costs incurred before an alternative begins meeting the requirement (e.g., status quo costs incurred during construction of a new facility).
>
> Sensitivity analyses can be performed on life cycle costs, life cycle benefits, and quantitative factors.
>
> Military construction EAs are cost effectiveness types, meaning the alternatives have the same benefits but different costs; the primary benefit (e.g., providing personnel with housing facilities) should be the same.

The examples above demonstrate the extension ECONPACK is designed to support military construction type of analysis. In addition, Figure 5.3 shows the software's list of costs associated with various cost kinds, along with possible data sources, also related to military construction.

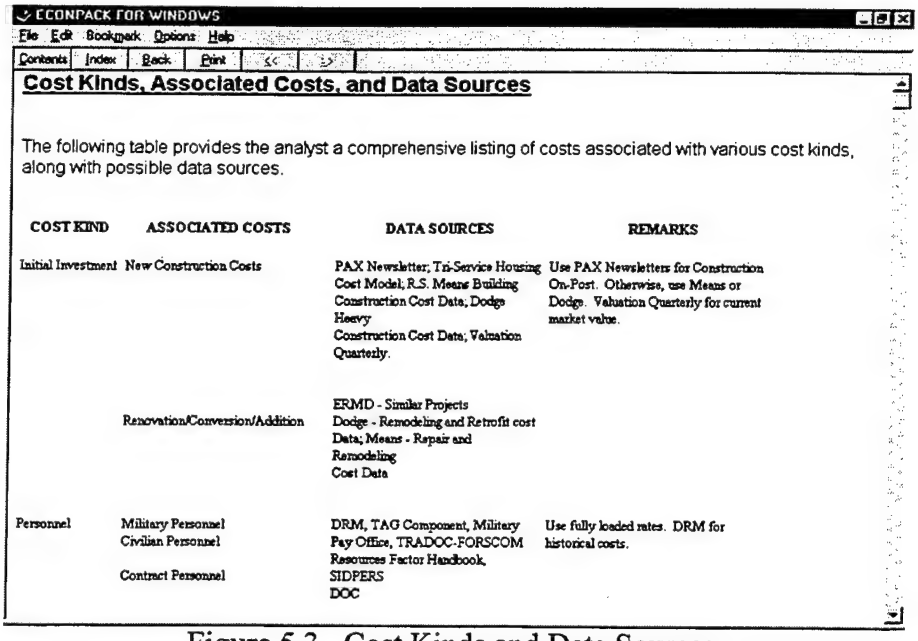

Figure 5.3. Cost Kinds and Data Sources.

ECONPACK can be used to support analyses other than military construction. Analysts performing any sort of economic analysis can benefit from the standardized methodology and calculations offered in the software. However, in using ECONPACK to perform analyses other than military construction projects, analysts should be careful about its specificity and be selective as to what elements of the software can be used.

5. Cost Estimates and Opportunity Cost

ECONPACK is structured to treat cost as a resource input to a project, program, or activity expressed in dollar terms. Costs are categorized in terms of basic units, such as labor or material and accumulated to form the total cost of each type. No consideration is given to the opportunity cost concept. In spite of OMB and DOD commitment to estimate costs as opportunity costs, the system's theory presented in the help program does not mention the concept. Therefore, analysts should be aware that they may be required to evaluate opportunity cost by themselves, partially compromising the software's goal of supporting non-economists to perform economic analysis.

F. ECONPACK AS A SUPPORTING TOOL

The considerations presented above portray the strengths and weaknesses of ECONPACK as an automated tool in supporting CBA studies. To validate our findings, we will use two previously performed cost-benefit studies and use ECONPACK to reproduce the analyses, calculations and reports. The objective is to verify the amount of assistance ECONPACK provides to analysts performing CBA and to substantiate the extent of the software adequacy in supporting such analyses. An overview of both

studies is first presented to allow the reader to understand the problem. The information presented in the overview section of each study was compiled from the studies themselves without judgment of value. Additional information can be obtained in the original studies.

1. Congressional Budget Office Study "The Costs and Benefits of Retail Activities at Military Bases"

a. CBO Study Overview

In 1997, the Congressional Budget Office (CBO) produced a study of the military commissaries and exchange system on military bases. [Ref. 28] The study examines the strengths and weaknesses of commissaries and exchanges as a way to compensate service members and to ensure that military personnel living overseas or in isolated U.S. locations have access to U.S. goods. The study also suggests alternative ways to meet both of these goals and looks at their costs and benefits. The alternatives mentioned in the study are: (1) to maintain the size, scope and pricing policy of the commissaries and exchange services while reducing operating costs; (2) to create a "DOD Resale Authority" to reduce budgetary costs; (3) to rely on private contractors for all on-base retail services; and (4) to revise incentives for retail activities, making DOD pay for the full operating costs, forgone taxes and forgone return on capital.

According to CBO, DOD provides an extensive network of retail stores and consumer services at its military bases for the use of current and retired service members and their families. Those DOD enterprises have annual sales of $14 billion and employ about 96,000 federal workers. Military commissaries, which are similar to civilian supermarkets, account for $5 billion of those sales. The stores and services furnished by the military exchange system accounts for the other $9 billion.

DOD argues that its current commissary's policy is profitable. For a cost of about $1 billion a year in appropriated funds, commissaries sell groceries with a wholesale value of $5.4 billion. At commercial prices, those groceries have a value of about $7.4 billion. Thus, the current policy yields about $2 billion in benefits ($7.4 - $5.4 = $2) for the cost of $1 billion in appropriated funds. According to DOD, each taxpayer dollar provides $2 worth of non-cash compensation to military personnel. Also, DOD argues that the exchange services offer savings to service members and, at the same time, generate sufficient revenue to overcome operating costs and to support other military programs.

CBO argues that federal appropriations pay for most of the commissaries' operating costs, including the salaries of 18,000 employees. Additionally, CBO

demonstrates that retail activities receive a subsidy from society in the form of a tax exemption, a monopoly over on-base retail service, and interest-free use of federal capital. Estimating the demand curve for DOD's retail activities, CBO makes the assumption that the total value of benefits to patrons equals 80 percent of their apparent financial savings and the deadweight loss – transfers from tax payers that does not accrue to any other group in society [Ref. 3:p. 62] – associated with DOD's retail activities is on the order of $700 million. [Ref. 28] Table 5.1 summarizes both DOD and CBO perspective of the benefits and costs of the retail activities.

	Perspective (Millions of US$)	
	DOD	CBO
Sales at Comercial Prices	7400.00	-
Sales at DOD Retail Prices	5400.00	-
Benefits to Patrons	2000.00	1300.00
Cost of Appropriated Funds	1000.00	2020.00
Deadweight Losses	-	700.00
Net Benefits/Costs	1000.00	-1420.00

Table 5.1. DOD and CBO Perspectives of the Benefits/Costs of Retail Activities.

b. ECONPACK Results

We attempted to use ECONPACK to reproduce the CBO study. We used the data provided in the study and entered it in the software without making any judgment as to its value. ECONPACK produced a printed report which main features follows:

- A project identification section containing the project title, the discount rate used, the start and base project year, the discounting model, and the project objectives.

- A list of the assumptions used, according to the text entered by the analysts in the "Text" module of the system.

- A list of economic indicators for each alternative used in the study. The economic indicators available are the net present value (NPV), savings to investment ratio (SIR), discounted payback period (DPP), and benefits to investment ratio (BIR). The indicators were useless in this case since we defined the project as having a one-year period and the start and base years as the same.

- A list of the non-monetary costs and benefits, according to the text entered by the analysts in the "Text" module of the system.

- The identification of the analyst and the organization performing the study.

- A "Life Cycle Cost Report" containing in formation on the costs, cost savings and present value of each alternative. This report also contains the discrimination of the present value along the project years – not applicable in this case – and a comparison of the status quo with each alternative, typical of ECONPACK's "primary economic analysis." The report ends with a summary of the present values of the investment, assets and salvage values used in the analysis, also not applicable in the CBO study.

c. Evaluation of the ECONPACK Results

In our attempt to reproduce the CBO study using ECONPACK, the obstacles encountered were:

- CBO used demand curve estimation to determine the amount of aparental financial savings that represents benefits to patrons. ECONPACK does not offer any tool to help the analyst to estimate consumer surplus. Thus, this part of the CBO study could not be reproduced.

- Filling out the fields, the software required inputting unnecessary information, such as discount rate, starting and base year. That information may be suitable for other types of analysis but not for this one. The CBO study basically compares and contrasts the costs and benefits of the retail activities between the DOD and society's perspective. Information about discounting is irrelevant in this case. Therefore, the specificity of the software does not allow tailoring it for a particular analysis. Figure 5.4 shows the fields that must be entered to perform an analysis using ECONPACK.

- CBO used surveys to compare exchange prices and commercial prices in order to measure the benefits generated by the exchange services. Probability methods were used to determine the consumers' shopping patterns and their estimated savings in support of the survey. ECONPACK does not have probability tools to support similar analyses.

- The data entered in ECONPACK cannot be tailored according to the analyst's needs. The set up is different from a regular spreadsheet and the fields cannot be formatted to permit a better visualization. ECONPACK's spread sheet format is standard and cannot be changed. Figure 5.5 shows the spreadsheet format in ECONPACK.

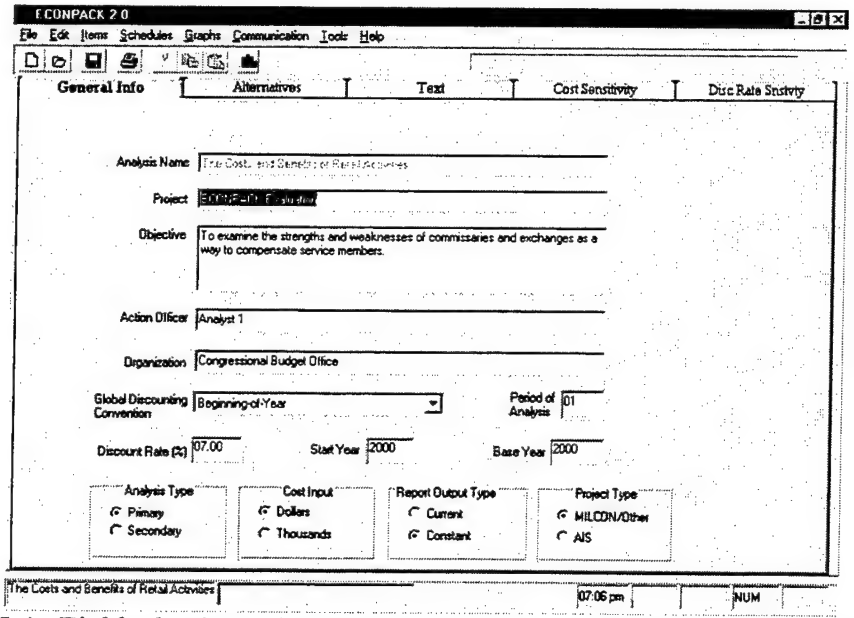

Figure 5.4. Fields that Must be Entered to Register an Analysis in ECONPACK.

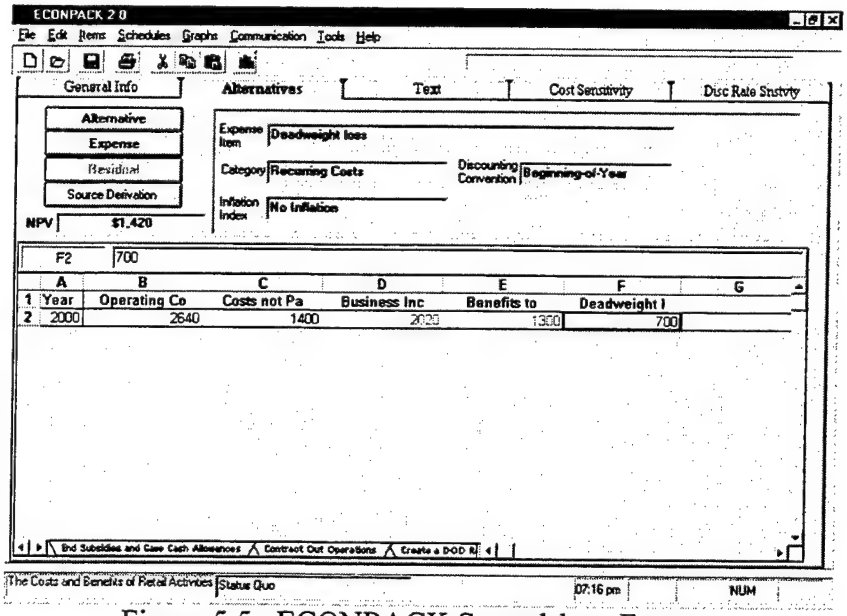

Figure 5.5. ECONPACK Spreadsheet Format.

- Assumptions, discussion of alternatives, non-monetary costs and benefits, and results and recommendations should be entered in a text format. An individual text screen is dedicated to each of these categories. However, the information cannot be viewed jointly. The only way to have an overview of all information inputted in the system is through the printing capability. Figure 5.6 shows the text capabilities.

- CBO points out $700 million in deadweight losses due to the tax exemption. ECONPACK does not have a proper register for deadweight loss. This concept is not mentioned in the system's theory section in the help program nor in the glossary of terms. This concept is unknown to ECONPACK.

- The CBO study compares the status quo with four alternatives. For this comparison, we choose to use ECONPACK's "primary analysis." The report produced, hence, compares the status quo with each alternative. Comparison among alternatives is not available in the report. In this case, analysts would have to use other software to complete the report and display a comprehensive analysis of the status quo and the four alternatives.

- CBO's analysis of the retail activities at military bases is a complex and detailed study, requiring economic understanding to correctly gather, interpret, analyze and drawn conclusions from the information available. In this case, ECONPACK does not supply analysts with sufficient tools so that non-economists can perform the study. ECONPACK's claim that "it is structured so it can be used by non-economists to prepare complete, properly documented economic analyses" [Ref. 27:p. 1-1] is not accurate in this case.

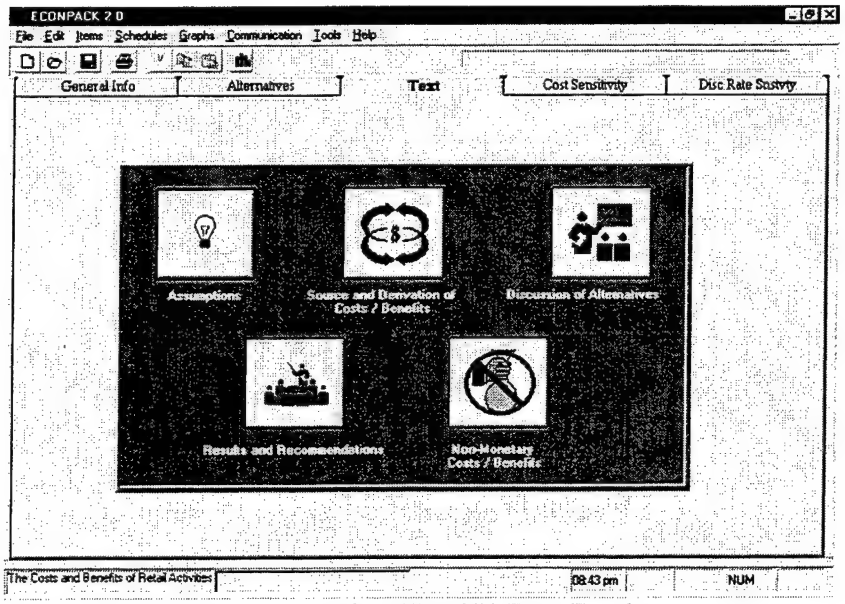

Figure 5.6. ECONPACK Text Entries.

In supporting analysts to perform studies similar to the CBO study, ECONPACK facilitates organizing the information. However, its applications do not extend to all types of CBA. The software offers minor help in performing supporting studies, such as the consumer's surplus estimation and the shopping patterns. It also does

not aid in tailoring the analysis according to the analyst's needs and to produce a comprehensive report of the study. The complete report produced by ECONPACK in reproducing CBO's study is available in Appendix C.

2. Cost-Effectiveness Analysis of the Operational Availability of the Brazilian and Argentinean A-4 Fleet

a. Study Overview

In their analysis of operational availability of the Brazilian Navy and the Argentinean Air Force A-4 Fleet, Karpovicz and Rodrigues performed a cost-effectiveness analysis to show potential savings from reducing both transportation time and inventory levels of A-4 spare parts. [Ref. 29] The study compares two scenarios – "sea mode" and "air mode." The "sea mode" scenario consists of the current transportation time and inventory levels of the A-4 fleet. The "air mode" scenario consists of a reduced transportation time and reduced inventory levels alternative, while maintaining the same operational availability of the A-4 aircraft.

The authors used standard net present value and discount rate concepts during a period of analysis of the current year plus ten years. The discount rate used was 10 percent and the inflation rate, four percent. [Ref. 29:p. 53] The "sea mode" and the "air mode" scenarios' transportation costs were assumed to follow a normal distribution, each one with two alternative standard deviation (sigma) of 20 and 30 percent. To evaluate risk, the authors performed Monte Carlo analysis and used the software Crystal Ball to do the calculations. Monte Carlo analysis is a simulation model that uses experimentation on chance (or probabilistic) elements by means of random sampling. It is basically used to perform risk analysis of investments. [Ref. 30:p. 815] Crystal Ball is a forecasting and risk analysis software designed to support the decision making process, using Monte Carlo simulation. [Ref. 31]

Table 5.2 reproduces the findings in the study.

Year	Sea Mode Sigma=20%	Sea Mode Sigma=30%	Air Mode Sigma=20%	Air Mode Sigma=30%
0	2237710	2237710	949244	949244
1	29147	29147	80070	80070
2	29497	29497	82472	82472
3	29851	29851	110430	110430
4	30209	30209	87372	87372
5	33629	33629	89810	89810
6	30938	30938	119922	119922
7	31309	31309	94686	94686
8	31685	31685	97124	97124
9	32066	32066	129431	129431
10	35695	35695	102000	102000
NPV	$2,469,591.57	$2,469,591.57	$1,619,519.81	$1,619,519.81

Table 5.2. Net Present Values of Alternatives.

b. ECONPACK Results

We attempted to use ECONPACK to reproduce the A-4 study. We used the data provided in the study and entered it in the software without making any judgment of value. In spite of the presence of the "status quo" alternative, we chose to use "secondary analysis" to differentiate the A-4 from the CBO study outcomes. ECONPACK produced a printed report which main features follows:

- An "Executive Summary Report" containing the same information about the project identification, assumptions, economic indicators, and non-monetary costs and benefits obtained in the CBO study reproduction. Exceptions are the savings to investment ratio (SIR), the discounted payback period (DPP), and the benefits to investment ratio (BIR) not available in secondary analysis.

- A detailed discrimination of the costs of each alternative, listed annually with their respective present values discounted for inflation.

- The cumulative net present value of each alternative discriminated by year. Figure 5.7 shows the net present value graph of the "Air Mode" and "Sea Mode" alternatives.

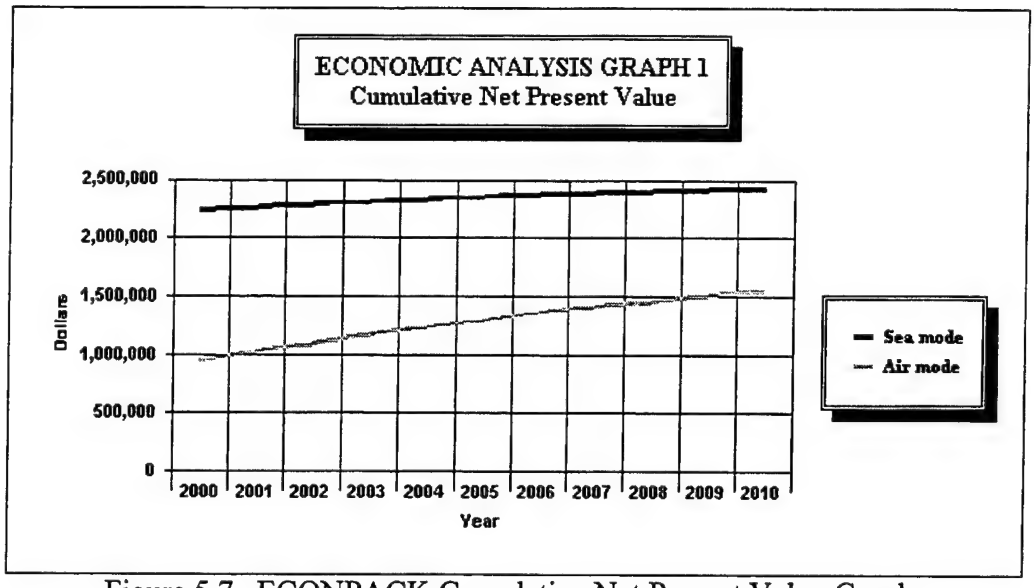

Figure 5.7. ECONPACK Cumulative Net Present Value Graph.

- A "Discount Rate Sensitivity Analysis" section showing the ranking of the alternatives for each discount rate in the interval chosen by the analyst. We used a discount rate interval of 7 to12 percent to verify the behavior of the alternatives and no changes in their raking occurred. Figure 5.8 shows the sensitivity graph produced by ECONPACK.

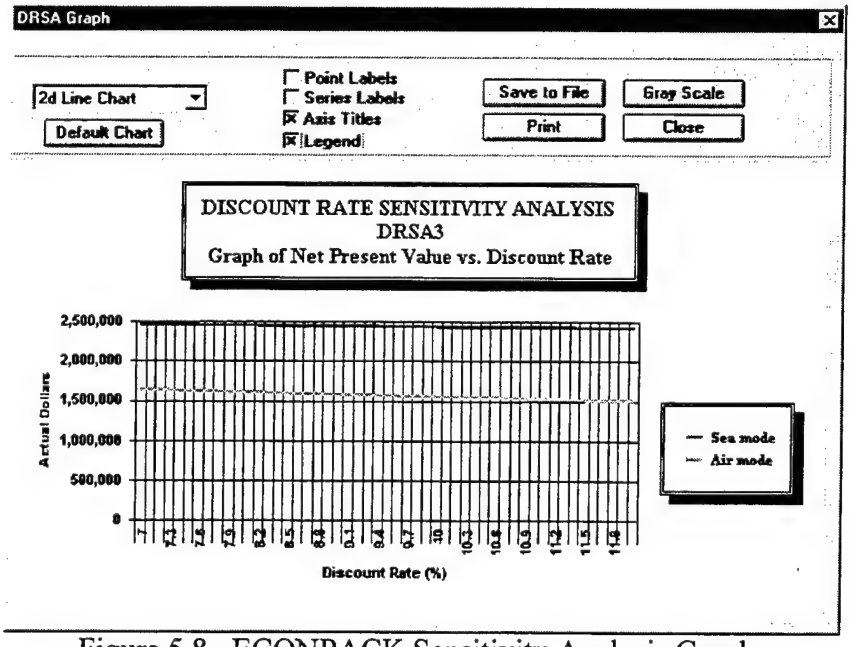

Figure 5.8. ECONPACK Sensitivity Analysis Graph.

- A table of the net present value of the alternatives calculated for each discount rate in the interval chosen by the analyst, 7 to 12 percent in this case.

c. Evaluation of the ECONPACK Results

In our attempt to use ECONPACK to reproduce the results of the simulation we encountered the following obstacles:

- ECONPACK does not have a simulation capability. The Monte Carlo simulation could not be reproduced, so the risk analysis was compromised. The analyst could not benefit from the assessment of uncertainty (variability) in the cost parameters.

- The calculations using ECONPACK were slightly different from the results obtained from Crystal Ball. The difference is due to the form of discounting inflation ($r = (i - m)/(1 - m)$ in the original study and ECONPACK uses $r = i - m$). Also, the randomness manifested in Crystal Ball contributes to the difference. However, the differences between the "sea mode" and "air mode" costs calculated using Crystal Ball and ECONPACK are below five percent and do not modify the rank of alternatives. Table 5.3 shows the costs of the scenarios obtained using both software.

MODE	Crystal Ball	ECONPACK	Difference	%
Sea Mode	$2,469,591.57	$2,429,541.00	$40,050.57	1.6%
Air Mode	$1,619,519.81	$1,546,218.00	$73,301.81	4.5%

Table 5.3. Costs of the Scenarios under ECONPACK and Crystal Ball Calculations.

- The text editing capability allows registering the assumptions made in the original study and integrating them in the final report.

ECONPACK is a beneficial tool in supporting cost-effectiveness studies. The text processing and spread sheet capabilities produce a rich final report. The software strength resides in its capability of performing comparison of alternatives and discount rate sensitivity analysis. The software's graphic design capability, similar to regular spreadsheets, produces a useful overview of the alternatives and their behavior, when submitted to discount rate variation. However, ECONPACK does not offer simulation tools to address uncertainty in the evaluation of alternatives. Simulation is a relatively straightforward and flexible process that can be used to analyze large and complex situations, addressing "what-if" types of questions to optional alternatives. [Ref. 30:p. 814] To perform Monte Carlo simulation, for instance, analysts would have to make use of complimentary software. The complete report produced by ECONPACK in reproducing the A-4 Fleet study is available in Appendix D.

G. CHAPTER SUMMARY

This chapter examined ECONPACK and its capabilities. We analyzed the seven step process the software conceptually follows in the economic analysis process. We differentiated between primary and secondary analysis and demonstrated how this differentiation influences the software's outcomes. We examined the software's method of discounting and discounting for inflation. The strengths and weaknesses of ECONPACK as a supporting tool in the application of cost-benefit principles were pointed out. Finally, we used two concrete examples, a CBO study about the costs and benefits of retail activities at military bases and a cost-effectiveness study of the operational availability of the Brazilian and Argentinean A-4 fleet, to demonstrate that ECONPACK is a software designed to support cost analysis and cost-effectiveness studies. Its use in broader CBA is not adequate and requires major modifications.

In the next chapter we will present the conclusions and recommendations we have derived from the survey of the existing CBA tools in DOD and from the appraisal of ECONPACK.

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VI. CONCLUSIONS AND RECOMMENDATIONS

A. INTRODUCTION

The previous chapters have presented an overview of the existing systems, software and automated tools available in the DOD environment to help analysts to perform cost-benefit and cost effectiveness analyses and to apply related analytical techniques. This final chapter presents our conclusions concerning the value of the software and automated tools and recommendations for improvements of the automated tools in support of CBA studies.

B. CONCLUSIONS

1. The Current State of the Software and Automated Tools Being Used in DOD to Perform Cost-Benefit Analyses

The current software and automated tools available in the DOD to support agencies' economic analyses focus mainly on the cost side of a given project. DOD efforts to refine its agencies' analytical capabilities are designed to collect and to retrieve cost data, and to produce an in-depth analysis of the cost components and their behavior during a project's life cycle. TRACES, AMCOS, PACES, COMET, and ARCM are all automated tools designed to collect, analyze and report different types of costs incurred in particular projects. Also, FCV/UM, VAMOSC and HAPCA are databases designed to warehouse information on historical costs.

2. The Congruence of the Software and Automated Tools with the Theoretical CBA Framework and with the DOD Regulations

The emphasis on the cost side of the analyses is justified by the main regulations governing DOD economic analyses that also center on the costs of a given project. Moreover, project benefits are often measured as costs avoided and it is often assumed that the main benefit of a project is to achieve the project goal. Thus, computation of true economic benefits is often not stressed. In supporting the budgetary decision-making process, the available software and automated tools offer significant aid to analysts since funding procedures are based on cost estimates. However, in policy evaluation studies where cost and full economic benefits should be estimated and measured according to the CBA theoretical framework, the lack of an effective tool meant to evaluate economic benefits weakens the usefulness of these tools.

Cost-benefit analysis is a very specific technique to evaluate public policies and programs. Software and automated tools that aim to help perform CBA should dedicate equal attention to the benefit side of the calculation. Disregarding any of these

parameters may lead to misinterpretation of the problem and, hence, to poorly informed decision-making.

3. ECONPACK's Value in Supporting CBA Studies

ECONPACK, the economic analysis tool most widely adopted by DOD agencies, is an example of software primarily designed to support cost analysis. When we reproduced the "A-4 Fleet" cost-effectiveness study using ECONPACK, the software could be considered a helpful tool. It produced useful comparative analyses, graphics and final reports due to its focus on the cost parameters. Nevertheless, reproducing a more theoretical study with broader economic benefits, such as CBO's "Costs and Benefits of Retail Activities at Military Bases," ECONPACK could not be used effectively and modifications were required to perform this type of analysis.

C. RECOMMENDATIONS

The lessons learned from the survey of the software and automated tools in the DOD designed to support CBA studies endorse the following recommendations.

1. Software and Automated Tools to Support CBA Studies Development

DOD agencies should develop software and automated CBA tools jointly. Currently, similar systems and similar databases have being developed by different agencies, duplicating efforts and incurring additional unnecessary costs. Initiatives toward linking DOD agencies' systems and databases, such as TRACES, should be encouraged. Shared tools and databases will increase the diversity and the quality of the cost and benefit data while reducing the burden of software development.

Also, modern technologies, such as web-based systems and data warehousing, should be taken into consideration during the software development process. These technologies allow more users to access the tools simultaneously and increase processing and data storage capabilities. Additionally, documentation and manuals can be Internet-based, easing the distribution process.

2. Congruence with CBA Theoretical Framework and DOD Regulations

Clear differentiation between automated tools designed to support CBA studies and to support life cycle cost studies should be made. Analysts should have in mind what type of analysis has to be performed and which automated tool best supports the study.

In addition, manuals, tutorials, and help programs should dedicate attention to basic theoretical CBA concepts and to DOD regulations in order to help non-economists to perform more accurate analyses.

3. Changes in the Analyst's Skills

Changes in the education requirements and skills of the analysts performing CBA studies might be considered to improve their knowledge of fundamental CBA concepts.

D. SUGGESTIONS FOR FUTURE RESEARCH

We suggest further research in the following areas:

- A survey of economic analysis software and automated tools developed by non-DOD Federal agencies and private firms.
- An analysis of the influence of uncertainty (variability) in investment project evaluation.
- An analysis of the influence of modeling and simulation in project or policy evaluation.
- Further analyses of the techniques for evaluating the economic benefits of projects or policies in the DOD environment.

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APPENDIX A. LIST OF ORGANIZATIONS THAT CONDUCT CBA

This Appendix contains a list of DOD and non-DOD agencies related with CBA and their respective Internet addresses (websites). It also contains the websites of the software and automated tools mentioned in this thesis.

DOD Agencies	Websites
Office of the Under Secretary of Defense	
• Acquisition and Technology	www.acq.osd.mil
• Comptroller	www.dtic.mil/comptroller
• Cost Analysis Improvement Group	www.dtic.mil/pae
Acquisition Reform Home Page	www.acq.osd.mil/ac
Acquisition Reform Studies Warehouse	www.acq.osd.mil/ar/section912.htm
Defense Acquisition University	www.acq.osd.mil/dau
Defense Innovation Systems Agency	www.disa.mil
Defense Systems Management College	www.dsmc.dsm.mil
DOD Costing References	www.dtic.mil/c3i/dodim/costweb.html
Defense Finance and Accounting Services	www.dfas.mil

Navy	Websites
Navy Center for Cost Analysis	www.ncca.navy.mil
DON Acquisition Reform	www.acq-ref.navy.mil
DON Office of Budget	navweb.secnav.navy.mil/budget
Naval Air Systems Command	www.navair.navy.mil
NAVAIR Cost Analysis Division	www.navair.navy.mil/air40/air42
Naval Facilities Engineering Command	www.navafac.navy.mil
Naval Postgraduate School	www.nps.navy.mil

Army/Air Force	Websites
Army Cost and Economic Analysis Center	www.ceac.army.mil
Army Corps of Engineers	www.usace.army.mil
Air Force Cost Analysis Agency	www.safm.hq.af.mil/afcaa/index.html
Air Force Civil Engineers Support Agency	www.afcesa.af.mil

Other Government Agencies	Websites
Argone National Laboratory – Cost Estimating and Analysis	www.dis.anl.gov/disweb/cecea
General Services Administration	www.gsa.gov
Office of Management and Budget	www.whithouse.gov/omb
Office of Personnel Management	www.opm.gov
Congressional Budget Office	www.cbo.gov
General Accounting Office	www.gao.gov
National Partnership for Reinventing Government	www.npr.gov
NASA Cost Estimating Resources	www.jsc.nasa.gov/bu2/
Department of Commerce	www.doc.gov
Federal Information Center	fic.info.gov

Non-Federal Organizations	Websites
Society of Cost Estimating and Analysis	www.erols.com/scea
International Society of Parametric Analysis	www.isps-cost.org
RAND Corporation	www.rand.org
Center for Naval Analysis Corporation	www.cna.org

Software and Automated Tools	Websites
ECONPACK	www.hnd.usace.army.mil/paxpxt/econ.html www.hq.usace.army.mil/cemp/e/ec/econ/econ.htm
TRACES	www.hnd.usace.army.mil/traces/index-1.asp
AMCOS	www.ceac.army.mil/amcos/amcosweb/demo/frame.htm
PACES	www.afcesa.af.mil/Directorate/ces/Civil/CostEngr/PACES.htm
FCV/UM	www.afcesa.af.mil/Publications/A-Grams/1997/www9721.html
COMET	www.ncca.navy.mil/comet/index.html
VAMOSC	www.ncca.navy.mil/vamosc/index.html
ARCM	www.navair.navy.mil/air40/air42/Database/ARCostModel/arcostmodel.html
HAPCA	www.navair.navy.mil/air40/air42/Database/HAPCA/hapca.html
BLCC	www.ntis.gov/fcpc/cpn6928.htm
SOCM	www.jsc.nasa.gov/bu2/SOCM/SOCM.html

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APPENDIX B. ECONPACK ENHANCEMENTS IN THE WINDOWS VERSION

This appendix contains a list of the enhancements and new features added to the ECONPACK 2.0 Windows version. This information was compiled from ECONPACK's help program and from the software's website. The new and improved features include:

Comprehensive Help Program. The HELP program provides context sensitive help, functional assistance, economic theory, as well as policy and regulation information. A search capability is also available to facilitate your finding the information needed. The help program substitutes the Version 4.0 User's Manual.

Guided Tour. The Guided Tour shows the procedure for entering the information needed to use ECONPACK to generate an economic analysis.

Database Workfile Structure. This type structure, as opposed to sequential text file structure in the DOS version, increases the flexibility inherent in the manipulating/sharing of data. Additionally, it enhances the features available in the program and increases speed and efficiency in movement, calculations, and processing.

Spreadsheet Type Entry of Cost Information and Various Schedules. When entering costs for each year of the analysis and values for residual and inflation schedules, users have access to an EXCEL type spreadsheet. This feature supports the use of formulas, as well as makes it very easy to duplicate, move, delete, and add data.

Custom Reports. This feature allows users to select the reports they want and the sequence in which the reports are to be printed.

Enhanced Graphics. The program offers the depicting of NPV, discount rate information, and cost sensitivity data in several chart formats. Discount Rate and Cost Sensitivity graphs are readily available and can be viewed as soon as the graphs are defined.

Improved Text Capabilities. 'Visual Writer' text capabilities support the selection of different fonts and pitch sizes, as well as the underlining, italicizing, and bolding of text. In entering data, users may also benefit from use of the cut, paste, copy, and spell features of the text editor.

Uploading/Downloading Economic Analysis Data. ECONPACK for Windows can be used to upload and download economic analysis data to and from a DD1391 Form in the DD1391 Module on the PAX System.

Windows enhancements. Using the new version, users can benefit from the Windows features, such as:

- 32-bit application.
- Database converted to Microsoft Access 97.
- Screen resolution of 800x600 pixels or higher.
- Communication using Transmission Control Protocol/Internet Protocol (TCP/IP)

APPENDIX C. ECONPACK TEST RESULTS – CBO STUDY

This appendix contains data printouts from ECONPACK Version 2.0 reproducing the CBO study "The Costs and Benefits of Retail Activities at Military Bases." The printouts represent a *primary* economic analysis. These are provided as documentation.

DATE GENERATED: 18 May 2000
TIME GENERATED: 13:10:22
VERSION: ECONPACK 2.0

The Costs and Benefits of Retail Activities
ECONOMIC ANALYSIS

EXECUTIVE SUMMARY REPORT

PROJECT TITLE : ECONPACK Evaluation
DISCOUNT RATE : 7%
PERIOD OF ANALYSIS : 1 Years
START YEAR : 2000
BASE YEAR : 2000
REPORT OUTPUT : Constant Dollars

PROJECT OBJECTIVE : To examine the strengths and weaknesses of commissaries and exchanges as a way to compensate service members.

ASSUMPTIONS OF THE ANALYSIS:

1. These estimates assume that the value of benefits to patrons is 80% of patrons financial savings.
2. Aparent financial savings are based on a 20% price difference between commissaries and comercial supermakets and 7.5% price difference between exchanges and comercial retailers.

ECONOMIC INDICATORS:

ALTERNATIVE NAME	NPV	SIR	DPP	BIR
1 End Subsidies and Gave Cash Allowan	-$1,400	N/A	N/A	N/A
2 Contract Out Operations	-$800	N/A	N/A	N/A
3 Create a DOD Resale Authority	-$800	N/A	N/A	N/A
4 Follow DOD Current Plan	-$200	N/A	N/A	N/A
5 Status Quo	$1,420	N/A	N/A	N/A

NON-MONETARY COSTS AND BENEFITS:

1. Alternative "Follow DOD Current Plan" represents:
   - Little change in costs or savings outside the Federal Budget.
   - Little change in standard of living for military personnel.

2. Alternative "Create a DOD Resale Authority" represents:
   - Some savings outside the Federal Budget if if scope of on-base activities decline.
   - Standard of living declines for retirees.

3. Alternative " End Subsidies and Give Cash Allowance declines standard of living for retirees.

ACTION OFFICER: Analyst 1
ORGANIZATION : Congressional Budget Office

LIFE CYCLE COST REPORT

1 End Subsidies and Gave Cash Allowances

YEAR	Operating Costs (1)	Cost Savings Outside (2)	TOTAL ANNUAL OUTLAYS	BEGINNING OF YEAR DISCOUNT FACTORS	PRESENT VALUE
2000	$200	-$1,600	-$1,400	1.000	-$1,400
%NPV	-14.29	114.29			
	$200	-$1,600			
DISCOUNTING CONVENTION	B-O-Y	B-O-Y			
INFLATION INDEX	No Inflation	No Inflation			

LIFE CYCLE COST REPORT

1 End Subsidies and Gave Cash Allowances

YEAR	CUMULATIVE NET PRESENT VALUE
2000	-$1,400

7% DISCOUNT RATE, 1 YEARS

PRIMARY ECONOMIC ANALYSIS

Status Quo Alternative: Status Quo
Proposed Alternative : End Subsidies and Gave Cash Allowances

Project Year(s)	Recurring Annual Operating Costs Status Quo Alternative	Proposed Alternative	Differential Costs	Present Value Factor	Present Value of Differential Costs
2000	$4,740	$200	$4,540	1.000	$4,540
Totals	$4,740	$200	$4,540		$4,540

PRIMARY ECONOMIC ANALYSIS

Total present value of investment	$0
Plus: present value of existing assets to be used	$0
Less: present value of existing assets replaced	$0
Less: present value of proposed alternative salvage value	$0
Total present value of net investment	$0
Total present value of differential costs	$4,540
Plus: present value of status quo investment costs eliminated	$0
Less: present value of status quo salvage value	$0
Total present value of savings	$4,540

Savings/Investment Ratio — No investment data
SIR is less than one at end of period of analysis

Total present value of savings	$4,540
Plus: present value of proposed alternative benefits	$1,600
Total present value of net benefits	$6,140

Benefits/Investment Ratio — No investment data

For Status Quo:

Recurring Costs - Expense Item(s)	1 2 5
Benefits - Expense Item(s)	3 4

For Proposed Alternative:

Recurring Costs - Expense Item(s)	1
Benefits - Expense Item(s)	2

LIFE CYCLE COST REPORT

2 Contract Out Operations

YEAR	Operating Costs (1)	Cost Savings b Outside Federal Budget (2)	TOTAL ANNUAL OUTLAYS	BEGINNING OF YEAR DISCOUNT FACTORS	PRESENT VALUE
2000	$800	-$1,600	-$800	1.000	-$800
%NPV	-100.00	200.00			
	$800	-$1,600			
DISCOUNTING CONVENTION	B-O-Y	B-O-Y			
INFLATION INDEX	No Inflation	No Inflation			

LIFE CYCLE COST REPORT

2 Contract Out Operations

YEAR	CUMULATIVE NET PRESENT VALUE
2000	-$800

7% DISCOUNT RATE, 1 YEARS

PRIMARY ECONOMIC ANALYSIS

Status Quo Alternative: **Status Quo**
Proposed Alternative : **Contract Out Operations**

Project Year(s)	Recurring Annual Operating Costs Status Quo Alternative	Proposed Alternative	Differential Costs	Present Value Factor	Present Value of Differential Costs
2000	$4,740	$800	$3,940	1.000	$3,940
Totals	$4,740	$800	$3,940		$3,940

PRIMARY ECONOMIC ANALYSIS

Total present value of investment	$0
Plus: present value of existing assets to be used	$0
Less: present value of existing assets replaced	$0
Less: present value of proposed alternative salvage value	$0
Total present value of net investment	$0
Total present value of differential costs	$3,940
Plus: present value of status quo investment costs eliminated	$0
Less: present value of status quo salvage value	$0
Total present value of savings	$3,940

Savings/Investment Ratio — No investment data
SIR is less than one at end of period of analysis

Total present value of savings	$3,940
Plus: present value of proposed alternative benefits	$1,600
Total present value of net benefits	$5,540

Benefits/Investment Ratio — No investment data

For Status Quo:

Recurring Costs - Expense Item(s)	1 2 5
Benefits - Expense Item(s)	3 4

For Proposed Alternative:

Recurring Costs - Expense Item(s)	1
Benefits - Expense Item(s)	2

LIFE CYCLE COST REPORT

3 Create a DOD Resale Authority

YEAR	Cost Savings (1)	TOTAL ANNUAL OUTLAYS	BEGINNING OF YEAR DISCOUNT FACTORS	PRESENT VALUE	CUMULATIVE NET PRESENT VALUE
2000	-$800	-$800	1.000	-$800	-$800
%NPV	100.00				
	-$800				

DISCOUNTING CONVENTION B-O-Y
INFLATION INDEX No Inflation

7% DISCOUNT RATE, 1 YEARS

PRIMARY ECONOMIC ANALYSIS

Status Quo Alternative: Status Quo
Proposed Alternative : Create a DOD Resale Authority

Project Year(s)	Recurring Annual Operating Costs: Status Quo Alternative	Recurring Annual Operating Costs: Proposed Alternative	Differential Costs	Present Value Factor	Present Value of Differential Costs
2000	$4,740	$0	$4,740	1.000	$4,740
Totals	$4,740	$0	$4,740		$4,740

PRIMARY ECONOMIC ANALYSIS

Total present value of investment	$0
Plus: present value of existing assets to be used	$0
Less: present value of existing assets replaced	$0
Less: present value of proposed alternative salvage value	$0
Total present value of net investment	$0
Total present value of differential costs	$4,740
Plus: present value of status quo investment costs eliminated	$0
Less: present value of status quo salvage value	$0
Total present value of savings	$4,740

Savings/Investment Ratio — No investment data
SIR is less than one at end of period of analysis

Total present value of savings	$4,740
Plus: present value of proposed alternative benefits	$800
Total present value of net benefits	$5,540

Benefits/Investment Ratio — No investment data

For Status Quo:

Recurring Costs - Expense Item(s) 1 2 5
Benefits - Expense Item(s) 3 4

For Proposed Alternative:

Benefits - Expense Item(s) 1

LIFE CYCLE COST REPORT

4 Follow DOD Current Plan

YEAR	Cost Savings (1)	TOTAL ANNUAL OUTLAYS	BEGINNING OF YEAR DISCOUNT FACTORS	PRESENT VALUE	CUMULATIVE NET PRESENT VALUE
2000	-$200	-$200	1.000	-$200	-$200

%NPV	100.00
	-$200
DISCOUNTING CONVENTION	B-O-Y
INFLATION INDEX	No Inflation

7% DISCOUNT RATE, 1 YEARS

PRIMARY ECONOMIC ANALYSIS

Status Quo Alternative: Status Quo
Proposed Alternative : Follow DOD Current Plan

Project Year(s)	Recurring Annual Operating Costs: Status Quo Alternative	Recurring Annual Operating Costs: Proposed Alternative	Differential Costs	Present Value Factor	Present Value of Differential Costs
2000	$4,740	$0	$4,740	1.000	$4,740
Totals	$4,740	$0	$4,740		$4,740

PRIMARY ECONOMIC ANALYSIS

Total present value of investment	$0
Plus: present value of existing assets to be used	$0
Less: present value of existing assets replaced	$0
Less: present value of proposed alternative salvage value	$0
Total present value of net investment	$0
Total present value of differential costs	$4,740
Plus: present value of status quo investment costs eliminated	$0
Less: present value of status quo salvage value	$0
Total present value of savings	$4,740
Savings/Investment Ratio	No investment data
SIR is less than one at end of period of analysis	
Total present value of savings	$4,740
Plus: present value of proposed alternative benefits	$200
Total present value of net benefits	$4,940
Benefits/Investment Ratio	No investment data

For Status Quo:

Recurring Costs - Expense Item(s)	1	2	5
Benefits - Expense Item(s)	3	4	

For Proposed Alternative:

Benefits - Expense Item(s)	1

LIFE CYCLE COST REPORT

5 Status Quo

YEAR	Operating Costs (1)	Costs not Paid by DOD (2)	Business Income (3)	Benefits to Patrons (4)	Deadweight loss (5)
2000	$2,640	$1,400	-$2,020	-$1,300	$700
%NPV	185.92	98.59	-142.25	-91.55	49.30
	$2,640	$1,400	-$2,020	-$1,300	$700
DISCOUNTING CONVENTION	B-O-Y	B-O-Y	B-O-Y	B-O-Y	B-O-Y
INFLATION INDEX	No Inflation	No Inflation	No Inflation	No Inflation	No Inflation

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APPENDIX D. ECONPACK TEST RESULTS – A-4 STUDY

This appendix contains data printouts from ECONPACK Version 2.0 reproducing the "Cost-Effectiveness Analysis of the Operational Availability of the Brazilian and Argentinean A-4 Fleet" study. The printouts represent a *secondary* economic analysis. These are provided as documentation.

DATE GENERATED: 18 May 2000
TIME GENERATED: 13:13:25
VERSION: ECONPACK 2.0

Operational Availability of A4 Fleet
ECONOMIC ANALYSIS

EXECUTIVE SUMMARY REPORT

PROJECT TITLE : ECONPACK Evaluation
DISCOUNT RATE : 10%
PERIOD OF ANALYSIS : 11 Years
START YEAR : 2000
BASE YEAR : 2001
REPORT OUTPUT : Current Dollars

PROJECT OBJECTIVE : To show potential savings from reducing transportation and inventory level in maintaining th A-4 Fleet

ASSUMPTIONS OF THE ANALYSIS:

1. Average Transportation costs follow a normal distribution.

2. The discount rate is 10% and the inflation rate os 4%.

3. Total costs equal acquisition costs plus transportation costs.

ECONOMIC INDICATORS:

	ALTERNATIVE NAME	NPV
1	Air mode	$1,546,218
2	Sea mode	$2,429,541

NON-MONETARY COSTS AND BENEFITS:

No data available.

ACTION OFFICER: Analyst 2
ORGANIZATION : Naval Postgraduate School

LIFE CYCLE COST REPORT

1 Air mode

YEAR	Acquisition Cost (1)	Transportation Cost (2)	TOTAL ANNUAL OUTLAYS	END OF YEAR DISCOUNT FACTORS	PRESENT VALUE
2000	$949,624	$0	$949,624	1.000	$949,624
2001	$0	$80,134	$80,134	0.909	$72,849
2002	$0	$82,571	$82,571	0.826	$68,241
2003	$0	$110,607	$110,607	0.751	$83,101
2004	$0	$87,547	$87,547	0.683	$59,796
2005	$0	$90,026	$90,026	0.621	$55,899
2006	$0	$120,258	$120,258	0.564	$67,883
2007	$0	$94,989	$94,989	0.513	$48,745
2008	$0	$97,474	$97,474	0.467	$45,472
2009	$0	$129,950	$129,950	0.424	$55,111
2010	$0	$102,450	$102,450	0.386	$39,499
%NPV	61.42	38.58			
	$949,624	$596,595			
DISCOUNTING CONVENTION	E-O-Y	E-O-Y			
INFLATION INDEX	Inflation of 4%	Inflation of 4%			

LIFE CYCLE COST REPORT

1 Air mode

YEAR	CUMULATIVE NET PRESENT VALUE
2000	$949,624
2001	$1,022,473
2002	$1,090,713
2003	$1,173,814
2004	$1,233,610
2005	$1,289,508
2006	$1,357,391
2007	$1,406,136
2008	$1,451,608
2009	$1,506,719
2010	$1,546,218

10% DISCOUNT RATE, 11 YEARS

LIFE CYCLE COST REPORT

2 Sea mode

YEAR	Acquisition Cost (1)	Transportation Cost (2)	TOTAL ANNUAL OUTLAYS	END OF YEAR DISCOUNT FACTORS	PRESENT VALUE
2000	$2,238,605	$0	$2,238,605	1.000	$2,238,605
2001	$0	$29,170	$29,170	0.909	$26,518
2002	$0	$29,532	$29,532	0.826	$24,407
2003	$0	$29,899	$29,899	0.751	$22,463
2004	$0	$30,269	$30,269	0.683	$20,674
2005	$0	$33,710	$33,710	0.621	$20,931
2006	$0	$31,025	$31,025	0.564	$17,513
2007	$0	$31,409	$31,409	0.513	$16,118
2008	$0	$31,799	$31,799	0.467	$14,835
2009	$0	$32,194	$32,194	0.424	$13,654
2010	$0	$35,852	$35,852	0.386	$13,823
%NPV	92.14	7.86			
	$2,238,605	$190,936			
DISCOUNTING CONVENTION	E-O-Y	E-O-Y			
INFLATION INDEX	Inflation of 4%	Inflation of 4%			

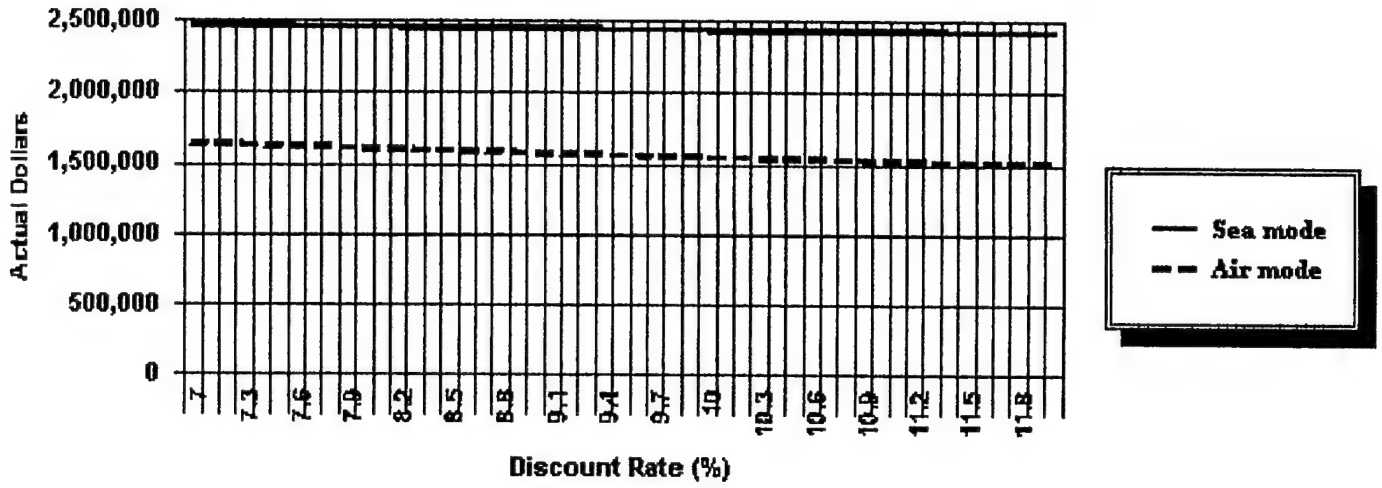
LIFE CYCLE COST REPORT

2 Sea mode

YEAR	CUMULATIVE NET PRESENT VALUE
2000	$2,238,605
2001	$2,265,124
2002	$2,289,531
2003	$2,311,994
2004	$2,332,668
2005	$2,353,599
2006	$2,371,112
2007	$2,387,230
2008	$2,402,065
2009	$2,415,718
2010	$2,429,541

10% DISCOUNT RATE, 11 YEARS

DISCOUNT RATE SENSITIVITY ANALYSIS 1
DRSA3
Graph of Net Present Value vs. Discount Rate



DISCOUNT RATE SENSITIVITY ANALYSIS 1

TITLE: DRSA3

Summary of Alternative Rankings by Discount Rate

Discount Rate: 10.0 Lower Limit: 07.00 Upper Limit: 12.00

Discount Rate (%)	Alternative Ranking	Discount Rate (%)	Alternative Ranking
7.00	1 2	9.60	1 2
7.10	1 2	9.70	1 2
7.20	1 2	9.80	1 2
7.30	1 2	9.90	1 2
7.40	1 2	10.00	1 2
7.50	1 2	10.10	1 2
7.60	1 2	10.20	1 2
7.70	1 2	10.30	1 2
7.80	1 2	10.40	1 2
7.90	1 2	10.50	1 2
8.00	1 2	10.60	1 2
8.10	1 2	10.70	1 2
8.20	1 2	10.80	1 2
8.30	1 2	10.90	1 2
8.40	1 2	11.00	1 2
8.50	1 2	11.10	1 2
8.60	1 2	11.20	1 2
8.70	1 2	11.30	1 2
8.80	1 2	11.40	1 2
8.90	1 2	11.50	1 2
9.00	1 2	11.60	1 2
9.10	1 2	11.70	1 2
9.20	1 2	11.80	1 2
9.30	1 2	11.90	1 2
9.40	1 2	12.00	1 2
9.50	1 2		

RESULTS:

No change in the alternative ranking occurred.

DISCOUNT RATE SENSITIVITY ANALYSIS 1

TITLE: DRSA3

Table of Net Present Value for each Discount Rate

Disc Rate = 07.00%		Disc Rate = 07.10%		Disc Rate = 07.20%		Disc Rate = 07.30%	
Alt	NPV	Alt	NPV	Alt	NPV	Alt	NPV
1	$1,636,683	1	$1,633,346	1	$1,630,033	1	$1,626,743
2	$2,457,673	2	$2,456,636	2	$2,455,607	2	$2,454,584

Disc Rate = 07.40%		Disc Rate = 07.50%		Disc Rate = 07.60%		Disc Rate = 07.70%	
Alt	NPV	Alt	NPV	Alt	NPV	Alt	NPV
1	$1,623,478	1	$1,620,235	1	$1,617,016	1	$1,613,820
2	$2,453,570	2	$2,452,562	2	$2,451,561	2	$2,450,568

Disc Rate = 07.80%		Disc Rate = 07.90%		Disc Rate = 08.00%		Disc Rate = 08.10%	
Alt	NPV	Alt	NPV	Alt	NPV	Alt	NPV
1	$1,610,647	1	$1,607,496	1	$1,604,368	1	$1,601,262
2	$2,449,582	2	$2,448,602	2	$2,447,630	2	$2,446,664

Disc Rate = 08.20%		Disc Rate = 08.30%		Disc Rate = 08.40%		Disc Rate = 08.50%	
Alt	NPV	Alt	NPV	Alt	NPV	Alt	NPV
1	$1,598,178	1	$1,595,116	1	$1,592,075	1	$1,589,056
2	$2,445,705	2	$2,444,753	2	$2,443,808	2	$2,442,869

Disc Rate = 08.60%		Disc Rate = 08.70%		Disc Rate = 08.80%		Disc Rate = 08.90%	
Alt	NPV	Alt	NPV	Alt	NPV	Alt	NPV
1	$1,586,058	1	$1,583,081	1	$1,580,125	1	$1,577,190
2	$2,441,936	2	$2,441,010	2	$2,440,091	2	$2,439,178

Disc Rate = 09.00%		Disc Rate = 09.10%		Disc Rate = 09.20%		Disc Rate = 09.30%	
Alt	NPV	Alt	NPV	Alt	NPV	Alt	NPV
1	$1,574,275	1	$1,571,381	1	$1,568,506	1	$1,565,652
2	$2,438,271	2	$2,437,371	2	$2,436,477	2	$2,435,589

Disc Rate = 09.40%		Disc Rate = 09.50%		Disc Rate = 09.60%		Disc Rate = 09.70%	
Alt	NPV	Alt	NPV	Alt	NPV	Alt	NPV
1	$1,562,818	1	$1,560,003	1	$1,557,208	1	$1,554,432
2	$2,434,707	2	$2,433,831	2	$2,432,961	2	$2,432,097

DISCOUNT RATE SENSITIVITY ANALYSIS 1

TITLE: DRSA3

Table of Net Present Value for each Discount Rate

Disc Rate = 09.80%		Disc Rate = 09.90%		Disc Rate = 10.00%		Disc Rate = 10.10%	
Alt	NPV	Alt	NPV	Alt	NPV	Alt	NPV
1 -	$1,551,675	1 -	$1,548,937	1 -	$1,546,218	1 -	$1,543,518
2 -	$2,431,239	2 -	$2,430,387	2 -	$2,429,541	2 -	$2,428,700

Disc Rate = 10.20%		Disc Rate = 10.30%		Disc Rate = 10.40%		Disc Rate = 10.50%	
Alt	NPV	Alt	NPV	Alt	NPV	Alt	NPV
1 -	$1,540,836	1 -	$1,538,173	1 -	$1,535,527	1 -	$1,532,900
2 -	$2,427,866	2 -	$2,427,036	2 -	$2,426,213	2 -	$2,425,395

Disc Rate = 10.60%		Disc Rate = 10.70%		Disc Rate = 10.80%		Disc Rate = 10.90%	
Alt	NPV	Alt	NPV	Alt	NPV	Alt	NPV
1 -	$1,530,291	1 -	$1,527,699	1 -	$1,525,125	1 -	$1,522,569
2 -	$2,424,582	2 -	$2,423,775	2 -	$2,422,974	2 -	$2,422,177

Disc Rate = 11.00%		Disc Rate = 11.10%		Disc Rate = 11.20%		Disc Rate = 11.30%	
Alt	NPV	Alt	NPV	Alt	NPV	Alt	NPV
1 -	$1,520,029	1 -	$1,517,507	1 -	$1,515,002	1 -	$1,512,514
2 -	$2,421,387	2 -	$2,420,601	2 -	$2,419,821	2 -	$2,419,045

Disc Rate = 11.40%		Disc Rate = 11.50%		Disc Rate = 11.60%		Disc Rate = 11.70%	
Alt	NPV	Alt	NPV	Alt	NPV	Alt	NPV
1 -	$1,510,042	1 -	$1,507,587	1 -	$1,505,148	1 -	$1,502,726
2 -	$2,418,276	2 -	$2,417,511	2 -	$2,416,751	2 -	$2,415,996

Disc Rate = 11.80%		Disc Rate = 11.90%		Disc Rate = 12.00%	
Alt	NPV	Alt	NPV	Alt	NPV
1 -	$1,500,320	1 -	$1,497,930	1 -	$1,495,556
2 -	$2,415,246	2 -	$2,414,501	2 -	$2,413,761

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